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A Review of the Fisheries of the Mackenzie Delta and Nearshore Beaufort Sea

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A REVIEW OF THE FISHERIES OF THE MACKENZIE DELTA AND NEARSHORE BEAUFORT SEA

by

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PREFACE

This report is presented in fulfillment of the Department of Supply and Services Contract FP709-0-LX44 let to Aquatic Environments Limited for a study concerning the review of the fish resources of the Mackenzie River delta and the nearshore Beaufort Sea area for fishery management resource development potential and for identification of future research requirements. The work was done on behalf of the Fish and Marine Mammal Management Division, Fisheries Resource Section, Research and Resource Services Directorate, Fisheries and Oceans, Western Region. The report is published upon recommendation by Mr. R. W. Moshenko, Scientific Authority for this study.

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TABLE OF CONTENTS

	Page
ABSTRACT/RESUME	iv
INTRODUCTION	1
ANNOTATED BIBLIOGRAPHY	2
DOCUMENTATION OF UNPUBLISHED INFORMATION	17
COMMERCIAL, DOMESTIC, AND SPORT FISHERIES	17
Commercial fisheries	17
Commercial fish harvests for export and local markets	18
Domestic fisheries	19
Sport fisheries	20
ASSESSMENT OF AVAILABLE INFORMATION	20
Commercial fisheries	20
Anadromous species	21
Marine species	21
Freshwater species	22
Sport fisheries	22
Domestic fisheries	22
RECOMMENDATIONS FOR FUTURE USE	22
Domestic fisheries evaluations	22
Commercial fisheries	23
Stock differentiation	23
Marine fisheries assessment	23
Sport fisheries	23
ACKNOWLEDGMENTS	23
REFERENCES	23

LIST OF FIGURES

Figure		Page
1	Communities within the Northwest Territories	26
2	The Mackenzie River drainage basin	27
3	Location of Canadian Shield and Borderlands in Northwest Territories	28
4	The Mackenzie River Delta	29
5	Proposed commercial fishing regions of the Northwest Territories	30
6	Western Regional fisheries and area of operation of the Freshwater Fish Marketing Corporation	31
7	Principal commercial fishery areas in the Northwest Territories	32
8	Commercial fishery management areas of the Mackenzie River Delta	33
9	Areas defined for recreational (sport) fishing survey	34

LIST OF TABLES

Table		Page
1	Utilization of coastal waters by fish species commonly taken along the Mackenzie Delta	35
2	Fishes of the Mackenzie Delta and Beaufort Sea	38
3	List of freshwater fish species important in domestic, commercial, and sport fisheries in the Northwest Territories	39
4	Information sources for fish harvest data used in this report	40
5	Chronological development of commercial fishing attempts within the Mackenzie Delta and Beaufort Sea	41
6	Production of anadromous Arctic charr for the Cambridge Bay fishery(1960-1978)	43
7	Freshwater Fish Marketing Corporation regional fisheries for commercial catches of principal species, 1972-1979	45
8	Commercial catches of principal species, 1972-79 for the Northwest Territories	46
9	Commercial fish harvest from the Mackenzie Delta and environs, 1977-1980	46
10	Commercial fish harvest from the Central Arctic, 1976-1979	47
11	Seasonal fish harvests recorded for Cambridge Bay, Gjoa Haven, and Pelly Bay, 1974/75-1978/79	48
12	Summaries of commercial catch data from the Mackenzie Delta area, 1955-1980	48
13	Commercial fish sold locally from catches within and adjacent to the Mackenzie Delta, 1978	49
14	Commercial fish sold locally from catches within and adjacent to the Mackenzie Delta, 1979	49
15	Commercial fish sold locally from catches within and adjacent to the Mackenzie Delta, 1980	50
16	Estimates of annual harvests of domestic fish in the Mackenzie Delta and environs	51
17	Domestic fish data from the Mackenzie Delta and adjacent areas, 1978	52
18	Domestic fish data for the Mackenzie Delta and adjacent areas, 1979	52
19	Domestic fish data for the Mackenzie Delta and adjacent areas, 1980	53
20	Fish harvest for all fish caught in the Mackenzie Delta	53
21	Monthly distribution of sport fishing activity in the Northwest Territories in 1975	54
22	Number of sport fishing licenses issued in the Northwest Territories, 1970/71-1975/76	54
23	Angler fish harvest in the Northwest Territories	54
24	The distribution of licensed anglers within the Northwest Territories	55
25	Angling harvest estimates from camps and outfitters in Mackenzie Delta and environs	55

ABSTRACT

Corkum, L.D., and P.J. McCart. 1981. A review of the fisheries of the Mackenzie Delta and nearshore Beaufort Sea. Can. MS Rep. Fish. Aquat. Sci. 1613: v + 55 p.

This study is a review of fisheries in the Mackenzie Delta and nearshore Beaufort Sea with emphasis on commercial, domestic and sport harvests. Recommendations for fishery management and future research needs are outlined. An annotated bibliography is also presented for fish resources in the study area.

Of the 63 species of fish reported in the study area, only 17 are important for commercial, domestic or sport fishing. Broad whitefish *(Coregonus nasus)*, humpback or lake whitefish *(C. clupeaformis)*, Arctic cisco *(C. autumnalis)*, least cisco *(C. sardinella)*, inconnu *(Stenodus leucichthys)*, Arctic charr *(Salvelinus alpinus)*, lake charr *(S. namaycush)*, northern pike *(Esox lucius)*, and burbot *(Lota lota)* are the most abundant freshwater fishes. Fourhorn sculpin *(Myoxocephalus quadricornis)* are the most abundant marine fish of the Beaufort Sea.

Commercial fishing is the harvest of fish for export markets or local sale. Commercial fishing regulations are designed to provide fishermen with reasonable catches while preventing overfishing. The Mackenzie Delta, Cambridge Bay and the Hornaday River have been the three main centres for commercial fishing within the region. Although there is some interest in commercial fishing for Pacific herring, their distribution and relative abundance in the Beaufort Sea is unknown. Broad whitefish and Arctic charr are the major commercial fish species in the study area.

Several years of commercial fish harvest data for the Mackenzie Delta and Central Arctic region are presented in the report. Information on domestic fish catches and local commercial sales is presented for the Mackenzie Delta and adjacent areas for 1978 to 1980. The domestic harvest for 1978 to 1980 represents 79 to 83% of the total fish harvest in the Mackenzie Delta.

The strengths and weaknesses of the available information describing commercial, domestic and sport fisheries are discussed. In all these areas, a great deal needs to be done if there is to be an adequate basis for management as fisheries in the study area become more intensive in future.

Recommendations are made for future studies which will provide this data base. These include detailed studies of domestic, commercial and sport fisheries, as well as studies designed to differentiate stocks of fishes which enter various fisheries and an assessment of the marine fish resources.

Key words: annotated bibliography; catch/effort; catch statistics; commercial fishing; domestic fishing; fishery management; sport fishing.

RESUME

Corkum, L.D., and P.J. McCart. 1981. A review of the fisheries of the Mackenzie Delta and nearshore Beaufort Sea. Can. MS Rep. Fish. Aquat. Sci. 1613: v + 55 p.

La présente étude porte sur la pêche dans le le Mackenzie Delta et les régions côtières de la Beaufort Sea et plus particulièrement sur les pêches commerciale, familiale et sportive. On y fait des recommandations concernant l'aménagement des pêches et le besoin de faire de la recherche à l'avenir. L'étude comprend aussi une bibliographie annotée sur les ressources halieutiques de la région.

Seulement 17 des 63 espèces relevées dans la zone étudiée présentent de l'importance pour les pêches commerciale, familiale ou sportive. Les poissons d'eau douce les plus abondants sont le corégone tschir *(Coregonus nasus)*, le grand corégone *(C. clupeaformis)*, le cisco arctique *(C. autumnalis)*, le cisco sardinelle *(C. sardinella)*, l'inconnu *(Stenodus leucichthys)*, l'omble chevalier *(Salvelinus alpinus)*, le touladi *(S. namaycush)*, le grand brochet *(Esox lucius)*, et la lotte *(Lota lota)*. Quant au chabot de profondeur *(Myoxocephalus quadricornis)*, c'est le poisson d'eau salée le plus commun de la Beaufort Sea.

La pêche commerciale peut être définie comme la capture du poisson pour l'exportation ou la vente sur le marché local. Les lois qui la régissent sont conçues pour permettre la prise de quantités raisonnables de poisson et empêcher la surexploitation. Les trois principaux centres de pêche commerciale de la région sont le Mackenzie Delta, Cambridge Bay et la Hornaday River. Le hareng du Pacifique présente aussi un certain intérêt pour la pêche commerciale, mais son nombre et sa distribution dans la Beaufort Sea demeurent inconnus. Le corégone tschir et l'omble chevalier sont les espèces les plus importantes pour la pêche commerciale dans la région.

Cette étude fournit également des données, réparties sur plusieurs années, concernant la pêche commerciale dans le Mackenzie Delta et la région de l'arctique central ainsi que des données sur la pêche familiale et la vente sur le marché local dans le delta et les régions avoisinantes de 1978 à 1980. Pendant cette période, les prises effectuées pour la pêche familiale représentèrent de 79% à 83% de la récolte totale dans le Mackenzie Delta.

Le rapport étudie aussi la valeur des données dont on dispose actuellement sur les pêches commerciale, familiale et sportive. En effet, d'énormes progrès restent à accomplir dans ce domaine si l'on veut que les décisions relatives à la gestion s'appuient sur une information valable au fur et à mesure que la pêche acquiert de l'importance dans la région.

Des recommandations sont faites pour que l'on fasse des études qui seront la source de cette information, notamment des études exhaustives concernant les pêches familiale, commerciale et sportive, ainsi que des études ayant pour but de déterminer les stocks de poisson que comportent

les différentes pêches, et une évaluation des ressources halieutiques en eau salée.

Mots-clés: bibliographie annotée; prises/effort; statistiques de capture; pêche familiale; aménagement des pêches; pêche sportive.

INTRODUCTION

The Northwest Territories (NWT)(Fig. 1) encompass a total surface area of 3 376 698 km² of which freshwater areas constitute 132 092 km² (Mackay 1963). Great Bear Lake (31 080 km²) is the largest lake in the region. The Mackenzie River (Fig. 2), the largest river in Canada, flows 1 800 km from Great Slave Lake to the Beaufort Sea with a drainage area of 1.84×10^5 km² (Mackay 1963).

The productivity of freshwater areas in the north is low compared to waterbodies within the temperate region. Northern freshwater fishes are characterized by slow growth, late maturity, and long life (McCart and Den Beste 1979). Slow growth of northern fish is not always evident to fishermen catching trophy-size fish in previously unexploited lakes. Since northern fish have long lives, their total biomass, although quite large, represents stored production accumulated gradually over many years. The rate of energy stored in gonads is also slow resulting in fish populations which mature later and which spawn once every 2, 3, or 4 years, rather than yearly (McCart and Den Beste 1979).

Fish productivity is also lower in the Precambrian Shield than in the surrounding sedimentary regions. Chemical characteristics of watersheds differ depending on the geological region in which they occur (Livingstone 1963). Within the NWT, there are two types of bedrock, igneous rock of the Precambrian Shield and sedimentary rock (Fig. 3). Waters within or draining land within the Shield are low in dissolved solids and productivity. Waters originating within or draining sedimentary regions (e.g., the Mackenzie Valley, Arctic coastline, and Arctic Islands) have relatively higher levels of dissolved solids and are more productive.

This study examines the fish resources in the Mackenzie Delta and the coastline of the Beaufort Sea. We have included fish data from tributaries of the Mackenzie River south of the Delta, Arctic Red and Tree rivers, and from lentic areas to the east and west as part of the Delta region (Fig. 4). It is possible that areas of coastline within the Central Arctic (Fig. 5, Region IV) are utilized by fish populations of the Beaufort Sea during some periods of their life history.

The Mackenzie Delta serves as a passageway for anadromous fish species, a locale for resident fish, and as a spawning site for other fish species. Because of the myriad of channels, lakes, and rivers in the Delta, some of which are very deep (30 m), it is extremely difficult to assess fish populations in the area. The available data on the distribution, nursery areas, feeding, and wintering areas of anadromous, freshwater, and marine fishes which utilize the Mackenzie Delta and Beaufort Sea have been summarized by Slaney & Co. (1976)(Table 1).

Of 63 species of fish reported for the Mackenzie Delta and Beaufort Sea (Table 2), only 17 are important for commercial, domestic, or sport fishing (Table 3). The most abundant freshwater fishes in the area are broad whitefish *(Coregonus nasus)*, humpback or lake whitefish *(C. clupeaformis)*, Arctic cisco *(C. autumnalis)*, least cisco *(C. sardinella)*, inconnu *(Stenodus leucichthys)*, Arctic charr *(Salvelinus alpinus)*, lake charr *(S. namaycush)*, northern pike *(Esox lucius)*, and burbot *(Lota lota)*.

Fourhorn sculpin *(Myoxocephalus quadricornis)* are the most abundant marine fish in off-shore areas of the Beaufort Sea (Bray 1975; Percy 1975; Slaney et al. 1976; Byers and Kashino 1980). Other brackish or marine species include saffron cod *(Eleginus gracilis)*, Arctic cod *(Boreogadus saida)*, starry flounder *(Platichthys stellatus)*, Arctic flounder *(Liopsetta glacialis)*, and Pacific herring *(Clupea harengus)*. The latter occur in Liverpool Bay and the Eskimo Lakes (Bray 1975).

Many northern fishes (Arctic charr, Arctic cisco, least cisco, broad and humpback whitefishes) have anadromous populations, i.e., the fish migrate to sea and feed during the summer returning to freshwater habitats in the fall to spawn and overwinter. Anadromous fish species tend to utilize the nearshore coastal waters of the Beaufort Sea as feeding areas or as pathways to feeding locations (Craig and McCart 1976; Johnson 1977). Least cisco and Arctic charr originating from watersheds west of the Delta forage along the Beaufort Sea coastline and do not enter freshwater tributaries there (Craig and McCart 1976). In contrast, some fishes (broad and humpback whitefishes, least cisco) which leave the Mackenzie Delta and migrate east along the Tuktoyaktuk Peninsula utilize the coastline as a passageway to freshwater forage sites. Several of the watersheds along the Tuktoyaktuk Peninsula appear to be very productive in terms of their utilization by these coregonids as summer feeding areas (K. Chang-Kue, personal communication). Migratory runs of Arctic cisco also occur in Liverpool Bay and the Eskimo (Husky) Lakes (Bray 1975).

Little is known about lake dwelling populations of the Tuktoyaktuk Peninsula; however, recent studies by the Department of Fisheries and Oceans, not yet published, will fulfil this data gap (M. Lawrence, personal communication).

Information on domestic, commercial, and sport fish harvests has been sporadically reported. Although several workers (Bissett 1967; Barlishen and Webber 1973; Olesh 1979) have recorded the development of commercial fishing in the Mackenzie Delta and data on export (outside of Canada) fish sales of the Freshwater Fish Marketing Corporation are maintained by the Department of Fisheries and Oceans, information on local sales is inadquate. Prior to 1978, few data were available for domestic fish harvests. Sport fishing data for the study area are very limited. In this report we present the collated domestic and commercial fish data recently collected by local fishery officers in the Mackenzie Delta.

The purpose of this report is to provide a review of fish resources of the Mackenzie Delta and nearshore Beaufort Sea. The report includes an annotated bibliography, documentation of unpublished information, an analysis of commercial, domestic, and sport fisheries, a synthesis of the

present fishery management, resource development potential, and recommendations for future biological studies necessary for fishery management.

ANNOTATED BIBLIOGRAPHY

The following section is an annotated bibliography of the published literature on the fish resources of the Mackenzie River Delta and the Beaufort Sea. The literature search for the material was conducted at the Freshwater Institute Library, Department of Fisheries and Oceans (DFO), Winnipeg. Occasionally, articles on broader topics or geographical areas were included if the material was applicable to the study area.

Atkinson, C. 1976. Development and potential yield of arctic fisheries, p. 389-402. *In* Assessment of the Arctic marine environment: selected topics. Univ. Alaska. Inst. Mar. Sci. Occas. Publ. 4.

This paper was presented at a symposium held in conjunction with the Third International Conference on Port and Ocean Engineering under Arctic Conditions, POAC-75. There has been little advance in the technology and management of fisheries in the Arctic seas, however, development of the oil fields along the Beaufort Sea has added new dimension to the Alaskan Arctic. With improved transportation and communication, the once isolated villages are rapidly disappearing. High rates of unemployment and substantial funds made available under the Native Claims Act have given a new incentive to leaders of the native groups to manage their resources in order to assure a continuing income in the future. Arctic fisheries are one of the resources that could be developed in this time of rapidly changing conditions. There is a growing need for assessment of the arctic fisheries, their potential yield and the problems associated with their development.

Barlishen, W.J., and T.N. Webber. 1973. A history of attempts to commercially fish the Mackenzie River Delta, Northwest Territories. A submission prepared for section three of the Federal Territorial Task Force Report on fisheries development in the Northwest Territories. MS Rep. 22 p.

Data for this report were obtained from government files in Yellowknife. The historical outline of the commercial fisheries in the Mackenzie Delta from 1960 to 1973 provides insight into the many problems facing the industry. It is evident that there are sufficient quantities of fish in the region but marketing and transportation costs present major difficulties. Information on quotas, fishing effort and catch statistics is also given for the region.

Beak Consultants Limited. 1978. Summary of post-construction impacts of linear facilities on northern ecosystems. Prepared for Environmental Protection Service. 117 p.

This report reviews the literature on the effects of linear developments (roads, railways and pipelines) on northern ecosystems (terrain, hydrology, vegetation, birds, mammals and aquatic systems). Relatively little information is available on the effects of highways and pipelines on northern aquatic environments. Past studies have focussed on the impacts of culverts, winter road systems, low water crossings and pipelines. However, the study of these impacts dwells on only one trophic level (i.e. fish or benthos or periphyton). No integrated holistic study has been attempted. Moreover, most research on petroleum impacts have focussed on marine environments.

Beak Consultants Limited. 1978. Heavy metals project Mackenzie Delta and estuary. Beak Consultants Limited. 213 p.

In the summer of 1977, Imperial Oil commissioned a study on the influence and source of toxic metals associated with their oil exploration operations. Public concern had been expressed over bio-accumulations of certain heavy metals in the environment and man. Heavy metal monitoring was started at one existing and one proposed artificial drilling island. Netserk F-40, located in an estuarine environment in the Beaufort Sea has been rapidly eroding since exploratory drilling completion. Isserk F-27 was being constructed in a shallow marine environment. Water, sediment and benthic invertebrate samples were taken from the area around each drill site as well as four channels in the Mackenzie Delta. The study proposed to identify the presence and distribution of six heavy metals: mercury, arsenic, cadmium, chromium, lead and zinc. Netserk F-40 was found to have benthos with high mercury levels but the low biomass in the area eliminated the threat of high level accumulation. Isserk F-27 construction distributed fine material over existing sediments, smothering some benthic populations. Water quality in the four test channels was similar to Netserk F-40, yet origins of the mercury traces were unknown. Fish and whale flesh had metal concentrations similar to other Arctic waters and were safe for consumption. Belugas had higher concentrations of mercury, lead and zinc than the fish. Waste drilling fluids pose no serious environmental danger. No significant bio-accumulation was found in benthic organisms. Erosion of old drilling islands will cover any harmful wastes. Miminum levels of heavy metals are recommended for drilling operations, the waste being disposed in depressions near the drill site for controlled burial. Additional oceanographic and current measurements would be useful to facilitate safer disposal of toxic wastes.

Bendock, T.N. 1977. Beaufort Sea estuarine fish study. Alaska Department of Fish and Game. 50 p.

Fish surveys were conducted along 163 km of the Beaufort Sea coastline between the Colville and Canning rivers over a two year period, July 1975 to September 1977. In all, 28 369 fish

representing seven families and 15 species were captured. During the open water season, freshwater and anadromous species dominated the nearshore fauna accounting for 52% of the catch. Arctic charr, Arctic cisco and least cisco were the most widespread and abundant anadromous fishes. Fourhorn sculpin and Arctic cod were the two most abundant marine species.

Anadromous fishes enter the Beaufort Sea after ice break-up and forage along the coastline. Adults return to freshwater systems to spawn and overwinter before juveniles and nonspawning members of the same species. Movements of juveniles are restricted to less saline protected waters of river deltas and lagoons. Anadromous whitefish and charr spawn during the fall in varied habitats from groundwater springs to isolated pockets of under-ice water in river deltas.

Berger, T.R. 1977. Synopsis of volume two. Mackenzie Valley Pipeline Inquiry. Report to the Minister of Indian Affairs and Northern Development. 30 p.

This is a summary of volume two of the Mackenzie Valley Pipeline Inquiry reports. It was written in the form of a letter from Mr. Justice Thomas R. Berger, the commissioner of the Mackenzie Valley Pipeline Inquiry to the Honourable Warren Allmand, Minister of Indian Affairs and Northern Development. Volume two is designed to serve as a convenient point of departure for people in both the public sector and the private sector who will be engaged in planning for the Mackenzie Valley and the Mackenzie Delta in the years to come. This volume indicates terms and conditions that relate to four distinct kinds of problems: renewable resources, urban centres, employment and northern business. Some of the subjects covered in volume two are: people and social and economic concerns including renewable resources, transportation and communications and economic growth. The environment and land is also discussed including physical environment, wildlife, fish, and land resources.

Bissett, D. 1967. The lower Mackenzie Region: an area economic survey. Dep. Indian Affairs and Northern Development, Industrial Division, Northern Admin. Branch. 520 p.

A portion of this report is devoted to domestic, sport and commercial fishing in the Mackenzie Delta. Major domestic fishing occurs along the Peel and Arctic Red rivers. Fishermen begin setting gillnets in July to harvest a portion of the herring (cisco) and inconnu runs. Occurrence and use of major fish species are presented as well as the location of popular fish camps throughout the delta. Estimates of local fish utilization, sales and commercial fish harvests are presented. A brief history of commercial fishing is outlined as well as a forecast of marketing problems.

Brakel, W.D. 1977. The socio-economic importance of wildlife resource utilization in the southern Beaufort Sea. Dep. Fisheries and the Environment, Beaufort Sea Project Tech. Rep. 32: 91 p.

This study investigates the socio-economic importance of renewable, natural resource use in the Beaufort Sea area. Changes in the marine environment, resulting from offshore drilling, could alter resource use patterns and their socio-economic importance by modifying the distribution and abundance of marine, biological resources. The resources considered are marine-related, since the Beaufort Sea provides their habitat or their food. Fishes, seals, whales, polar bears and arctic fox are included in this study. Utilization is defined as man's consumption of these resources for domestic or trade purposes. Socio-economic considerations include the level of utilization, its value and its relative importance to the users, to individual settlements and to regional economies.

Bray, J.R. 1975. Marine fish surveys of the Mackenzie Delta area. Fish. Res. Board Can. Biol. MS Rep. Ser. 1326: 4 p + tables.

A marine fisheries survey was conducted in July and August, 1961, along the Tuktoyaktuk Peninsula and within Liverpool Bay and Eskimo Lakes. *Myoxocephalus quadricornis* (fourhorn sculpin) was the most abundant species along the Tuktoyaktuk Peninsula near Warren Point and easily caught by seining with mesh sizes of 1.5-3 inches. Fishing could be sustained along this coast if likely areas were fished in rotation. Trawling is most remunerative within the environs of Tuktoyaktuk, otherwise the technique is hampered by shallow depths.

Migratory runs of *Coregonus autumnalis* (Arctic cisco) and *Clupea harengus* (Pacific herring) were evident in Liverpool Bay. An outflow of freshwater from the Eskimo Lakes watershed concentrates the plankton in saline bottom areas at a depth of five fathoms attracting sea herring to feed.

Brunskill, G.J., D.M. Rosenberg, N.B. Snow, G.L. Vascotto, and R. Wagemann. 1973. Ecological studies of aquatic systems in the Mackenzie-Porcupine drainages in relation to proposed pipeline and highway developments. Vol. 1. Task Force on Northern Oil Development, Environmental-Social Committee Northern Pipelines, Report 73-40: 131 p.

Plants and animals that live in rivers, streams and lakes (and the physical and chemical parameters that control their growth and reproduction) are being studied as indicators of aquatic ecosystem sensitivity to disruption of gas and oil pipelines and road developments in the Mackenzie and Porcupine river valleys. In 1971 and 1972, Fisheries Research Board staff performed a broad chemical and biological survey to identify the different types of ecosystems and the species of organisms in this vast area. From this data, three areas were selected for more intensive study in 1972-1975, these are: Fort Simpson area, being in the discontinuous permafrost region of the upper Mackenzie Valley lowlands; the Mackenzie Delta, a fertile and diverse labyrinth of lakes and channels; and the Porcupine River region west of Old Crow (Yukon), being a biologically unique glacial refugium and an area where local natives

are largely dependent upon undisturbed seasonal movements of fish and other wildlife.

Bryan, J.E. 1973. Influence of pipeline development on freshwater fishery resources of northern Yukon Territory. Aspects of research conducted in 1971 and 1972. Task Force on Northern Oil Development, Environmental-Social Committee Northern Pipelines Report 73-6: 63 p.

Routes have been proposed through both watersheds. Some physical and chemical characteristics are described for most rivers and creeks. Present information indicates that more fish spawning and rearing areas would be affected by a pipeline in the Porcupine River drainage than in the Beaufort Sea drainage. Most charr and grayling spawning and over-wintering areas lie upstream of the prospective pipeline route in the Beaufort drainage. In the Porcupine drainage, however, spawning and over-wintering habitat for many species is downstream of the prospective route. For five of the sixteen fish species captured in the Porcupine drainage, there are no presently known or suspected spawning grounds which would not be affected by a pipeline along the suggested route. A number of recommendations are made about safeguards to be followed during construction operation, and abandonments of pipelines. Fisheries service should have the responsibility to approve plans and scheduling of pipeline river crossings. Many procedures are suggested to minimize sedimentation of flowing water. A number of topics which require further research are described. The most important of these are: location of additional spawning areas; location of over-wintering sites; experiments to determine effects of sediment and crude oil on adult fish, fry and eggs; further development of safeguards for pipeline construction, operation and abandonment.

Bryant, W.J., J.R. Goldburn, Jr., and S.E. Hrudey. 1974. Water pollution aspects from waste drilling mud disposal in Canada's Arctic, p. 95 - 106. *In* 1974 Offshore Technology Conference, vol. 2. Houston, May 6-8, 1974.

Current oil and gas exploration drilling in Canada's Arctic poses potential water pollution hazards to the sensitive environment of the North. Much of this drilling is now concentrated in low-lying areas subject to flooding, such as the Mackenzie Delta, and in late 1973 drilling began in the shallow regions of the Beaufort Sea. This industrial activity can constitute a source of water pollution if drilling fluids are discharged to adjacent surface waters. A literature review has revealed little information on the water pollution characteristics of drilling fluids. In order to evaluate the pollution aspects and to identify appropriate environmental controls, an industry/government research program was established in 1973 to determine the magnitude of the problem, and, as a result of these investigations, to develop effluent standards and guidelines for the disposal of waste drilling fluids. This paper describes the studies being conducted and highlights the results of the 1973 work. On the basis of the results obtained to date, indications are that water base drilling fluids constitute a wastewater with characteristics capable of causing water pollution. Such wastes have been demonstrated to be acutely toxic to fish.

Byers, S.C., and R.K. Kashino. 1980. Survey of fish populations in Kugmallit Bay and Tuktoyaktuk Harbour, Northwest Territories. Prepared for Dome Petroleum by Seatech Limited. 20 p. + 6 figures + 24 tables.

During August and September 1980, a survey was conducted in Kugmallit Bay and Tuktoyaktuk Harbour to determine the presence of migratory fish and to monitor their movements. Scanning sonar was used to locate fish populations offshore; the equipment was less effective at depths less than 10-15 metres. Sixteen fish species (6 anadromous, 7 brackish or marine and 3 freshwater) were recorded including two fishes new to the area, polar cod *(Arctogadus glacialis)* and the seasnail *(Liparis cyclostigma)*. Anadromous boreal smelt was the dominant offshore fish. Other anadromous fish (Arctic cisco, least cisco, broad whitefish, humpback whitefish and inconnu) were found inshore. Biomass estimates of groundfish obtained by otter trawl varied depending on distance from shore: 9 500 kg/km² (within 0.5 km of shore), 15 000 kg/km² (1 km of shore), 6 000 kg/km² (6 km of shore). The dominant demersal fish was the fourhorn sculpin. Arctic cisco was the most dominant species within Tuktoyaktuk Harbour. Wind force and salinity appear to be the most significant factors influencing the movement and habits of migratory fish in Kugmallit Bay and Tuktoyaktuk Harbour.

Carter, L.J. 1976. Oil drilling in the Beaufort Sea; leaving it to luck and technology. Science 191:929-931.

Plans to sell leases for potential oil and gas bearing tracts on the U.S. intercontinental shelf continue to generate outcries from state and local officials and environmental leaders worried about possible adverse impacts. The Canadian government has moved towards a final decision to allow exploratory oil drilling to begin in the Beaufort Sea.

Corrigan, R. 1974. Oil companies eye gulf of Alaska. Mar. Technol. Soc. J. 8: 3-8.

As the petroleum industry seeks new deposits of oil and natural gas in untested regions, public attention has focused on the question of whether and when drilling may start off the Atlantic coast. Judging from industry and government reports, offshore Alaska looks likely to become the next prime drilling ground, even in the face of steep technological and financial barriers, and despite severe risks of damage to the marine and coastal environment.

Craig, P.C. 1977. Ecological studies of anadromous and resident populations of Arctic char in the Canning River drainage and adjacent coastal waters of the Beaufort Sea, Alaska. Chapter 1. Canadian Arctic Gas Study Limited, Alaskan Arctic Gas Study Co. Arctic Gas Biological Report 41: 116 p.

The Canning River is a moderate-size arctic drainage on the North Slope of Alaska. It forms the western boundary of the Arctic National Wildlife Range. The drainage supports large populations of Arctic charr *(Salvelinus alpinus)* and grayling *(Thymallus arcticus*, but few other fish species. Two taxonomic forms of *S. alpinus* occur in the drainage. The eastern arctic form occurs as a lake-resident found in two headwater lakes, one of which contains a population of extremely slow-growing fish. These dwarf charr may reach 13 years of age but do not exceed 190 mm in length. Arctic charr found throughout the remainder of the drainage area are of the western Arctic-Bering sea form. Prevalent life history patterns are anadromy and stream-dwelling non-anadromy in which only mature males are present. Also found are several self-perpetuating non-anadromous populations of charr inhabiting isolated springs and a single lake-resident population. No other lake-resident populations of western charr have been found in the western Arctic. Movements of arctic charr in a perennial spring were studied. The spring was utilized as 1) a spawning ground for sea-run charr and residual males, 2) a summer feeding area for fry and some older juveniles, and 3) an overwintering area for juvenile charr, especially those in their first or second winters of life.

Craig, P., and P.J. McCart. 1974. Fall spawning and overwintering areas of fish populations along routes of proposed pipeline between Prudhoe Bay and the Mackenzie Delta. Chapter 3 - 1972-1973. Canadian Arctic Gas Study Limited. Alaskan Arctic Gas Study Co. Arctic Biological Report 15: 37 p.

This study was undertaken to identify areas that are critical to fish populations in streams in Alaska and Yukon Territory lying close to the alternative routes of the natural gas pipeline that have been proposed by the Canadian Arctic Gas Study Limited. Because most of the pipeline construction is scheduled for the winter months, the authors have been particularly concerned about a) the location of overwintering areas and b) the spawning grounds of the fall spawning species. The data presented in this report are intended first, to contribute towards a comparative environmental assessment of these alternative routes and second, to indicate specific geographical areas that will necessitate special consideration once a particular route is selected.

Craig, P.C., and P.J. McCart. 1975. Classification of stream types in Beaufort Sea drainages between Prudhoe Bay, Alaska and the Mackenzie Delta, Northwest Territories, Canada. Arct. Alp. Res. 7:183-198.

Arctic streams in Beaufort Sea drainages from Prudhoe Bay, Alaska to the Mackenzie delta are described and classified. Mountain streams originate in the arctic mountain province and are the largest streams in the study area. These are cold waters (usually less than 10°C) which flow about five months of the year. Arctic charr is the common fish species in these streams, and the density of benthic invertebrates is typically low (100 organisms per square metre). Spring streams are small spring-fed tributaries of mountain streams. Most are freshwater with temperatures of 3-7°C although thermal and mineral springs do occur. The springs are inhabited by Arctic charr and high densities of benthic invertebrates (10,000 organisms per square metre). Tundra streams originate in the foothills and coastal plain provinces and flow for 3.5 to 4.5 months of the year. Their waters are stained brown and have a lower pH, conductance and lower concentrations of calcium than found in mountain or spring streams. Summer water temperatures may exceed 16°C. These streams are used as spawning and rearing areas by grayling. Densities of benthic invertebrates are between the other stream types.

Craig, P.C., and P. McCart. 1976. Fish use of nearshore coastal waters in the western Arctic: emphasis on anadromous species, p. 361-388. *In* Assessment of the Arctic marine environment: selected topics. Univ. Alaska. Inst. Mar. Sci. Occas. Publ. 4.

This paper was presented at a symposium held in conjunction with the Third International Conference on Port and Ocean Engineering under Arctic Conditions, POAC-75. An overview of fish utilization of nearshore habitats is presented for the Beaufort Sea coastal region between the Colville River (Alaska) and the Mackenzie River (Northwest Territories). Movements and life histories of anadromous species, principally the Arctic charr and Arctic cisco, are emphasized. Most of the 28 fish species caught in nearshore areas are freshwater or anadromous rather than marine. Areas of greatest species diversity are centred in the deltas of the largest drainages, most notably the Mackenzie Delta. Potential sources of disturbance to fish in the nearshore habitats are discussed.

Craig, P.C. and W. Griffiths. 1978. Beaufort Sea barrier island-lagoon ecological process studies. Ecology of fishes in Simpson Lagoon, 1977. LGL Limited. 71 p.

This report examines the biological processes and habitats of fish to assess their vulnerability to petroleum development. Simpson Lagoon and other nearshore areas provide an abundant food supply on which the fish can feed. Anadromous and marine fishes enter nearshore waters in early spring and accumulate food reserves for spawning or over-wintering requirements. Three anadromous fishes (Arctic cisco, Arctic charr and least cisco) and two marine fishes (fourhorn sculpin and Arctic cod) account for almost all the fish captured. The authors suggest that, while nearshore habitats are essential feeding areas for fish, nearshore biological processes and habitats are less vulnerable to impacts of petroleum development than other locations or stages in the life cycles of key fish species.

Dahlke, L.W., and M.R. Falk. 1979. Data on Arctic char from the Jayco River, Northwest Territories, 1975. Can. Fish. Mar. Serv. Data Rep. 156: iv + 11 p.

This project obtained baseline biological information on Arctic charr *(Salvelinus alpinus)* in the Jayco River on Victoria Island from July 3 to 15 and August 2 to September 6, in 1975. Fish were caught by angling and also with gillnets and fish fences. In all, 228 charr were sampled and 301 tagged. Biological and tagging data are presented in tabular form for Arctic charr and Arctic cisco.

Davies, K.F. 1973. Hydrometric data collection in the Mackenzie River basin. Task Force on Northern Oil Development, Environmental-Social Committee Northern Pipelines, Report 73-5: 88 p.

This report, (Report No. 73-5), Task Force on Northern Oil Development, Environmental-Social Program, Northern Pipelines, outlines the operations of water survey of Canada in the Mackenzie Valley area, with emphasis on the period since the inception of the Environmental-Social Program, Northern Pipelines. The objectives of the survey are as follows: 1) to prepare an inventory of surface water data for the Mackenzie basin, 2) to provide basic hydrometric data to indicate possible flood magnitudes and peak stages at breakup, 3) to provide river level forecasts on the Mackenzie navigation routes, 4) to document the sediment transport in fish production areas and 5) to act as a consultant on matters pertaining to surface water. A pipeline route along the Mackenzie Valley would cross many streams. Rates of water flow, timing and magnitude of flood peaks, scour depths and ice thickness are some of the hydrological parameters that are required for design and construction purposes. The area of the study consists of the Mackenzie drainage basin from Hay River through the Mackenzie Delta and the North Slope of the Yukon Territory from the British Mountains to the Beaufort Sea. Within the area, a number of rivers have been selected for study.

De Graaf, D., and K. Machniak. 1977. Fisheries investigations along the cross Delta pipeline route in the Mackenzie Delta. Chapter 4. Canadian Arctic Gas Study Limited, Alaskan Arctic Gas Study Co. Arctic Gas Biological Report 39: 169 p.

Fisheries investigations were conducted along the proposed Arctic Gas Cross Pipeline route in the Mackenzie Delta. Distribution and life history information are presented for all 20 fish species collected. Humpback whitefish, least cisco, northern pike, broad whitefish and ninespine stickleback were the most abundant and widespread species in the study area. Lakes and channels in the study area are utilized by a variety of fish species for feeding, spawning, rearing and migration.

Dryden, R.L., B.G. Sutherland, and J.N. Stein. 1973. An evaluation of fish resources of the Mackenzie River valley as related to pipeline development. Vol. 2. Task Force on Northern Oil Development, Environmental-Social Committee Northern Pipelines, Report 73-2: 176 p.

In 1972, the addition of a new base camp at Aklavik justified an expansion of the synoptic survey into the Mackenzie Delta and Yukon border areas. For each stream surveyed, the following conditions were assessed: watercourse type, riverbank conditions, flow conditions and assessment of the fish resources. A limited delta lake survey was also included. An intensive gill netting effort was conducted on the Great Bear River system in late September and early October. Helicopter time was also used to assist base crews in establishing overnight camps on remote lakes such as Swan Lake and Three Day Lake.

Falk, M.R., and L.W. Dahlke. 1979. Data on the Arctic char sport fishing at Tree River, Northwest Territories, 1978. Fish. Mar. Serv. Data Report 153: 32 p.

During July and August 1978, a creek census and biological sampling program was conducted on Tree River, a tributary to Coronation Gulf, Northwest Territories. The 472 anglers interviewed spent a total of 4 495 hours fishing Success rates for charr were 1.11 per angler and 0.12 per angler-hour. The total catch was estimated to be 2 186 Arctic charr with 24 per cent of the catch retained, resulting in a total harvest of 524 charr. Data on the biology of Arctic charr and other fish species (Arctic cisco, broad whitefish and lake whitefish) are presented in tabular form. Information on hooking mortality and tagging is also presented.

Fenge, T., J.E. Gardner, J. King, and B. Wilson. 1979. Land use programs in Canada - Northwest Territories. Environment Canada, Lands Directorate. 296 p.

In this report, the roles of federal and territorial agencies involved in land use planning and/or management in the Northwest Territories are outlined. Concerns and issues of land use and land management are discussed in detail. There are pertinent chapters on water management, the environment, agriculture, forestry, communities, tourism and recreation, parks, fish and wildlife, energy resources and transportation.

Friesen, B.F. 1975. Potential Inuit benefits from commercial and sports use of Arctic renewable resources. Inuit Tapirisat of Canada. Renewable Resources Project. Vol. 10: 176 p.

This report focusses on economic benefits which the Inuit may derive from further commercial and sports development of wildlife and fish resources. This abstract emphasizes only the fisheries potential.

The abundant fish resources is not uniformly distributed as lakes tend to be unique and show much variation in their fish populations without exhibiting great differences in their physical characteristics. Thus, detailed resource inventories should precede all planned fisheries.

Experience with commercial fisheries indicates that some subsidization assistance is necessary due to high transportation costs. The most promising potential fisheries are at Nettilling Lake, Baffin Island, and Holmes Creek, Mackenzie Delta. Nutrient feeding and mining or

rotational harvests of fish are two mechanisms suggested to increase fishery returns. The former is in the experimental stage and the latter is likely to have adverse long-term biological effects.

Galbraith, D.F., and D.C. Fraser. 1974. Distribution and food habits of fish in the eastern coastal Beaufort Sea. Interim Report of Beaufort Sea Project Study B1 (Eastern). 12 p. + figures + tables.

During 1973 and 1974, fish populations of inshore coastal waters in the southeastern Beaufort Sea, particularly in Kugmallit Bay and along the Tuktoyaktuk Peninsula, were investigated. Coregonids, especially Arctic cisco *(Coregonus autumnalis)* and least cisco *(Coregonus sardinella)*, and rainbow smelt *(Osmerus mordax)* were most abundant. Several marine species were found within the influence of the Mackenzie River. Pacific herring *(Clupea harengus)* was the most abundant marine species gillnetted. Food items from the stomachs of four species (Arctic cisco, least cisco, rainbow smelt and Pacific herring) were examined.

Gill, D. 1976. The Mackenzie River Delta and upstream hydroelectric developments, p. 43-49. *In* Mackenzie Delta: Priorities and Alternatives, Conference Proceedings. December 3-4, 1975. Canadian Arctic Resources Committee.

The purpose of this paper is to provide some basic environmental and ecological principles for the Mackenzie Delta, and to relate what the delta means and can mean to Canadians. The natural environment of the delta is reviewed in terms of landscape functions, some of the physical and biological interactions that take place and how its environment can be degraded by hydro-electric developments in its upstream reaches. Major topics reviewed include: the extremely variable annual runoff that characterizes the flow regime of Mackenzie River tributaries, the ecological effects of stream flow regulation, primary plant succession in the delta, alluvial wildlife habitats, waterfowl, aquatic furbearers, big game animals and aquatic habitats including fish. The author stresses the increasing value to society of wild rivers, natural landscape and the need for areas where northerners can pursue traditional livelihoods which will oppose industrial interests.

Graves, F.F., and J. Den Beste. 1976. Investigations of the aquatic resources in the Taglu-Richards Island and Parson Lake areas, Northwest Territories. Vol. II. Appendix and stream catalogue. Aquatic Environments Limited. 140 p.

A catalogue of data is presented for waterbodies in the study area. For each lake surveyed, data are presented for snow and ice conditions, physical features, phytoplankton, zooplankton, benthic macroinvertebrates, fish, and water chemistry. When appropriate, additional comments are made.

Griffiths, W., A. Sekerak, and M. Jones. 1974. Distribution of fish species along alternative gas pipeline corridors in Alaska, the Yukon Territory and Northwest Territories. Chapter II. Canadian Arctic Gas Study Limited, Alaskan Arctic Gas Study Co. Arctic Gas Biological Report 17: 189 p.

As part of the assessment of the potential impact of gas pipelines on fish populations a considerable body of information has been gathered concerning the distribution of various fish species along alternative corridors in Alaska, Yukon Territory and the Northwest Territories. In view of current interest in northern development and associated problems, this summary of published and unpublished reports and data should prove useful to other groups and agencies concerned with fisheries management or environmental assessment in these areas. The study is divided into three main sections. Section 1 is a list of watersheds and the fish species found in each. Section 2 lists each fish species and all locations for which data are available. Section 3 consists of maps showing the major drainages, the locations of the alternative corridors, the locations of major drainages and the distribution pattern of each fish species.

Griffiths, W., P. Craig, G. Walder, and G. Mann. 1975. Fisheries investigations in a coastal region of the Beaufort Sea, Nunaluk Lagoon, Yukon Territory. Chapter II. Canadian Arctic Gas Study Limited, Alaskan Arctic Gas Study Co. Arctic Gas Biological Report 34: 219 p.

The nearshore coastal environment in the Arctic is one of stark biological contrasts. For some nine months of the year, the area is ice-locked and shallow waters are frozen to the bottom substrates. However, during the short open-water season (July through September), nearshore habitats (e.g., lagoons and areas not deeper than 5-10 m) become important feeding and rearing areas for fish, especially anadromous species from the nearby rivers. To date, there have been few intensive biological studies of nearshore environments along the Beaufort Sea coast. The present study was designed to provide baseline data on the ecology of major trophic levels, from macroinvertebrates to fish, in nearshore and estuarine habitats. The construction of the proposed pipeline along the coastal route will require the use of staging areas, wharves and stockpile sites at several locations along the coast and it is important that information on nearshore habitats be available so that measures can be designed to reduce environmental impact. Construction will involve some short-term local disturbance of nearshore habitats as well as a considerable amount of barge traffic along the coast for a period of several summers. There is also a possibility that materials (e.g., sediments) originating upstream at pipeline river crossings may affect nearshore habitats downstream. This report emphasizes fisheries information, specifically distribution, life histories and food habits of the three most abundant species, Arctic charr *(Salvelinus alpinus)*, Arctic cisco *(Coregonus autumnalis)* and fourhorn sculpin *(Myoxocephalus quadricornis)*.

Griffiths, W.B., J.K. Den Beste, and P.C. Craig. 1977. Fisheries investigations in a coastal region of the Beaufort Sea, Kaktovik Lagoon, Alaska. Chapter 2. Canadian Arctic Gas Study Limited, Alaskan Arctic Gas Study Co. Arctic Gas Biological Report 40: 190 p.

The Kaktovik Lagoon (Barter Island, Alaska) study was designed to provide seasonal baseline data on the ecology of benthic invertebrates and fish at a proposed staging site on the Beaufort Sea coast in Alaska. In 1975, surveys were carried out during late winter (May), during the open water period from June to September, and during early winter (November). Samples were collected from a variety of sites in Kaktovik Lagoon and adjacent areas and, where possible, results compared to a similar study conducted a Nunaluk Lagoon (Yukon Territory), the previous year. A variety of physical and chemical parameters were recorded throughout the open water season: temperature, salinity, pH, conductivity, dissolved oxygen, macronutrients and major ions. Benthic invertebrates were sampled using coring devices, Ekman grabs and dredge hauls. Twelve fish species were collected in Kaktovik Lagoon. Life history information was obtained for the five most abundant species: Arctic charr, Arctic cisco, fourhorn sculpin, least cisco and Arctic cod. Seasonal abundance, diel variation and food habits of the major species were studied. The Kaktovik domestic fishery was monitored in 1975. An estimated 3 000 kg of Arctic charr, Arctic cisco, lake trout and Arctic cod were taken by Kaktovik residents. Results from both Kaktovik and Nunaluk lagoons were similar but there were some differences resulting from the following: 1) lagoon depth, Kaktovik Lagoon was deeper than Nunaluk Lagoon and did not freeze to the bottom during the winter, thereby providing an ice-free refuge, 2) freshwater input, Kaktovik Lagoon was a more marine habitat than Nunaluk Lagoon. The latter received direct discharge from two large rivers, 3) geographic location, it is suggested that for some species (Arctic and least cisco), the fish caught at Nunaluk Lagoon originated from the Mackenzie River whereas those caught at Kaktovik Lagoon originated from the Colville River.

Hardy, R.M. and Associates. 1978. Geophysical evaluation of granular material resources, Tuktoyaktuk Harbour, Northwest Territories. Dep. Indian Affairs and Northern Development. 49 p.

This report outlines the results of a geophysical survey of Tuktoyaktuk Harbour, Northwest Territories, as requested by the Department of Indian Affairs and Northern Development (DIAND), and represents the second phase of a granular materials inventory conducted for the Tuktoyaktuk area. The first phase of the study encompassed an area within a 48 km (30 mile) radius of Tuktoyaktuk, and included an investigation of granular deposits on land, near shore and offshore. The geophysical survey provided bathymetric data, and subbottom profiles of near surface stratigraphy representing lower and higher density materials. Maps of bathymetric contours and of low density material isopachs were prepared from the geophysical survey data. Based on a geological assessment of the study area, it is assumed that the low density materials are silts and clays, while the higher density materials are sands and gravels. To establish subbottom soil types and their quality, a limited field drilling program has been recommended. Data from the drilling program can then be correlated with the geophysical survey, and extrapolated over the study area. Preferred areas for dredging of harbour bottom granular material resources have been delineated, based on the geophysical survey data. The preliminary criteria employed in establishing these areas were that water depths should range between 3 m and 9 m (9.8 and 29.5 feet), and that the soft sediment thickness should be less than 2 m (6.6 feet). The development and management of the granular material resources in terms of dredging techniques, equipment availability, overburden disposal, stockpiling of aggregate and environmental considerations related to dredging and stockpiling have been considered in a preliminary overview. Detailed studies of these considerations will be required if the in-situ materials are proven to be desirable for development.

Hnatiuk, J. 1976. An environmental research program for drilling in the Canadian Beaufort Sea. J. Can. Pet. Technol. 15:29-36.

A jointly funded environmental research program has been undertaken in the Beaufort Sea with good cooperation between industry and the federal government. Thus far, no alarming results have come to light which could preclude drilling in the area. The concern about the climatic effects of a major discharge of oil has been largely alleviated. Currently, the major concerns are the effects of oil on fisheries, sea bottom scouring and oil clean up techniques. A public interface program to communicate with northern natives and other public groups has been a highly desirable addition to this research.

Hnatiuk, J., A. Kovacs, and M. Mellor. 1978. A study of several pressure ridges and ice islands in the Canadian Beaufort Sea. J. Glaciol. 20:519-532.

The environmental conditions in the southern Beaufort Sea are described with special emphasis on pressure ridges and ice islands. Techniques for determining the geometric configurations and the physical and mechanical properties of sea-ice structures and ice islands are described. Profiles of pressure ridges were determined by surface surveys, drill-hole probes and side-looking sonar scanning. Multi-year pressure ridges with thicknesses up to 20 m and widths up to 120 m were examined in detail. The first-year ridge of 22 m thickness and 100 m width was studied. Results are given for several multi-year and the first-year ridges. Information obtained from dives under the ice is also given. Corresponding data are given for grounded ice islands with particular attention being given to contact between the ice and sea bed. A 20 m thick ice-island fragment grounded in 15 m of water was one of several investigated. Measurements of temperature , salinity, tensile strength, and compressive strength are given for ice taken from old pressure ridges and factors influencing the interpretation of test data were discussed. The data obtained in

this study will be used in engineering design studies for offshore structures for drilling and production of hydrocarbons from the Beaufort Sea area. Exploratory drilling in shallow water has already been carried out and offshore drilling from drillships is scheduled to commence in the study area during the open water season of 1976.

Hunter, J.G. 1975. Fishery resources of the western Arctic. Fish. Res. Board Can. Biol. MS Rep. Ser. 1335: 25 p. + tables.

Hunter describes the waterways of the lower Mackenzie Valley and adjacent waters, from Firth River in the west to Horton River in the east and coastal waters from Herschel Island east to Baillie Island, as a relatively shallow area with a substrate of sand, soft-mud and gravel. The distribution and relative abundance of common freshwater, euhaline and marine species are based on a survey from 1955-64 (most fish were caught by gillnetting). The four most economically important fish in the area are: *Coregonus nasus* (broad whitefish), *C. clupeaformis* (lake whitefish), *C. sardinella* (least cisco) and *Stenodus leucichthys* (inconnu). Most domestic fishing for human use and dog food was concentrated near villages.

Since 1960, fishing has been organized by the Department of Indian and Northern Affairs. Although some fluctuation in fish catch has been observed, stable numbers are associated with growing northern fishes. The Mackenzie system is more productive than adjacent arctic waters and hence indicative of a large potential freshwater fish resource.

Jessop, C.S., K.T.J. Chang-Kue, J.W. Lilley, and R.J. Percy. 1974. A further evaluation of the fish resources of the Mackenzie River Valley as related to pipeline development. Task Force on Northern Oil Development, Environmental-Social Committee Northern Pipelines, Report 74-7: 95 p.

This report encompasses the third year of a four year investigation into the fish resources of the Mackenzie River Valley. The primary objectives were to refine and add to life history data. Particular emphasis was placed on migration routes and timing, movements of fry and juveniles and fish life history studies on two tributaries. The fish tagging study was intensified and sampling was initiated in the eastern Mackenzie Delta, a critical area for which there is little information on the fish resources. Fish fences were constructed in Oscar Creek and the Trail River to monitor fish movements and to obtain spawning population estimates for these tributaries. Domestic fish surveys were conducted at Aklavik and Arctic Red River. Results presented in this report are primarily new or revised findings.

Jessop, C.S., and J.W. Lilley. 1975. An evaluation of the fish resources of the Mackenzie River valley based on 1974 data. Can. Fish. Mar. Serv. Tech. Rep. Ser. CEN/T-75-6: 97 p.

In April 1974, the Department of the Environment, Fisheries and Marine Service began the final year of a four year investigation into possible effects of pipeline construction on fish resources of the Mackenzie River valley. Base camps were operated at Aklavik, Norman Wells and Fort Simpson. New areas sampled by Mackenzie River crews included existing and proposed highway crossing areas and the headwaters of several river systems. A fish fence was constructed on the Trail River to obtain further information on spawning populations and the timing of migrations. At each base, species distribution and abundance, spawning and nursery habits and movements, migration routes and timing were investigated. Fish were collected with gillnets, seines, trap nets and by angling. Winter surveys were conducted from February to May in the Aklavik area, and during February in the Norman Wells and Fort Simpson areas to locate significant overwintering areas for fish in the Mackenzie River valley.

Jones, M.L. 1977. Water availability along the proposed Arctic Gas Pipeline route from Prudhoe Bay, Alaska, to the Mackenzie Delta, Northwest Territories. Chapter 1. Canadian Arctic Gas Study Limited, Alaskan Arctic Gas Study Co. Arctic Gas Biological Report 40: 83 p.

A water availability study was conducted along the prime route of the Arctic Gas Pipeline from Prudhoe Bay, Alaska, to the Mackenzie Delta, Northwest Territories. The purposes of this study were to: 1) identify potential water sources along the pipeline route, 2) determine the volumes of water available from these sources, 3) compare the volumes of water available with the estimated volumes of water required, 4) assess the environmental impact of water withdrawn from the potential sources, and 5) present recommendations regarding maximum withdrawal rates, construction procedures, etc., to maximize potential damage to aquatic habitats. The major conclusions and recommendations of this study are: 1) there are more than adequate quantities of water available to meet the estimated water requirements of the pipeline. Overall, the total estimated water requirements of 8 222 000 BBL would amount to slightly more than 1% of the approximately 550 967 000 BBL available in the lakes surveyed. In addition, the springs surveyed discharge approximately 5 807 000 BBL per day, slightly less than the total estimated water requirement, 2) water can be safely withdrawn from most of the lakes surveyed, provided that no more than 10% of the total volume of any lake is withdrawn, 3) water can be safely withdrawn from most of the springs surveyed, provided that: a) water is withdrawn from a single point downstream of fish concentrations and spawning areas, and that collection areas prescreened to prevent the entry of fish, b) natural spring channels are not excessively rechanneled or closely paralleled by access roads, c) angling is strictly prohibited. It is further recommended that: 1) additional site-specific biological, hydrological and engineering studies be conducted as final selections of water sources are made and 2) during the development of water sources and during water withdrawal, locations with known spawning or overwintering populations of fish be individually monitored by a fisheries biologist familiar with the lakes and springs of the North Slope.

Kendel, R.E., R.A.C. Johnston, M.C. Kozak, and U. Lobsiger. 1974. Movements, distribution, populations and food habits of fish in the western coastal Beaufort Sea. Interim Report of Beaufort Sea Project Study B1 (Western). 64 p.

The objective of this study was to collect baseline information regarding the inshore fisheries resource and to identify areas which could be critically affected by a major oil spill.

Of 18 species of fish from coastal waters, lagoons and estuaries, least ciscoes were most frequently caught with concentrations increasing from west to east; this species was most abundant east of Kay Point. Arctic cisco and fourhorn sculpin were widely distributed. Arctic charr were frequently caught between Herschel Island and Kay Point, but were absent from most areas to the east. Length distributions, age-length relationships and sex ratios are given for Arctic charr, Arctic cisco and least cisco.

Kendel, R.E., R.A.C. Johnston, U. Lobsiger, and M.D. Kozak. 1975. Fishes of the Yukon coast. Dep. Environment, Beaufort Sea Project Tech. Rep. Publ. 6: 114 p.

This report presents baseline information regarding the inshore fishery resources and the aquatic environment of the western coastal Beaufort Sea, and identifies areas that could be critically affected by a major oil spill. The areas of highest density and species diversification are Mackenzie Bay and Phillips Bay. Some of the life history information is presented along with a discussion of the available literature for each species. Age-length relationships, sex ratios and age at maturity are presented for most common species. A discussion of the feeding habits and results from chemical and physical measurements are included. Some concerns related to offshore drilling and the potential effects of an oil spill on the fisheries resources of the study area are discussed.

Kristofferson, A.H., and G.W. Carder. 1980. Data from the commercial fishery for Arctic char, *Salvelinus alpinus* (Linnaeus), in the Cambridge Bay area, Northwest Territories, 1971-1978. Can. Data Rep. Fish. Aquat. Sci. 184: iv + 25 p.

The Fisheries and Marine Service, Department of Fisheries and Oceans has monitored the commercial catch of anadromous Arctic charr in the Cambridge Bay area since 1971. Samples were taken at the fishing site or at the Cambridge Bay plant. Fork length, sex, round and dressed weight were recorded. Age was determined by counting growth rings of otoliths. Data from 1971-1978 are presented in the report.

Mann, G.J. 1975. Winter fisheries survey across the Mackenzie Delta. Aquatic Environments Limited. 26 p. + appendices.

This report presents data obtained from winter surveys conducted in October and November, 1974 and April, 1975. Site specific data from the surveys recorded on catalogue sheets are presented in the appendix. In all, 12 fish species were taken: least cisco, humpback and broad whitefish, inconnu, Artic grayling, northern pike, herring, boreal smelt, longnose sucker, ninespine stickleback and sculpins.

Lakes and small channels are used more extensively for overwintering than the larger channels. A large portion of Shallow Bay appears to be unsuitable for overwintering fish.

Mann, G.J., and P.C. Craig. 1974. Life history and distribution of the Arctic cisco *(Coregonus autumnalis)* along the Beaufort Sea coastline in Alaska and the Yukon Territory. Chapter IV. Canadian Arctic Gas Study Limited, Alaskan Arctic Gas Study Co. Arctic Gas Biological Report 20: 33 p.

Anadromous Arctic cisco were collected along the Beaufort Sea coastline in Alaska (between the Sagavanirktok and Canning rivers) and the Yukon Territory (between Craig Creek and the Babbage River). Samples from the two areas contained few young fish and exhibited similar growth rates but differed in age structure, length-frequency, state of maturity and sex ratio. Arctic cisco collected off the Alaskan coast consisted largely of immature fish, 91% age 4 to 7 (range, age 2 to 10). Males (61%) were predominant. In contrast, the Yukon fish were generally older (age 7 to 11, range 2 to 21) with fewer males (34%) and more mature fish (66%). The latter consisted of both spawners and non-spawners. The distribution of Arctic cisco was restricted to marine or brackish water in the study area. It appears that the sources of anadromous Arctic cisco stocks found in this region are the Colville and Mackenzie rivers.

Martell, A.M., and L.M. Casselman. 1975. Wildlife of the Mackenzie Delta region. Boreal Institute for Northern Studies. 265 p.

Much concern has been expressed both by delta area residents and other environmentally conscious groups over the impact of petroleum exploration and development activities on the wildlife of the region, which has been the mainstay of the delta economy for all but 10 of the last 10 000 or more years. It is primarily for this reason that wildlife was chosen for this report, the chief natural resource of the delta area. This report serves as an updated compendium of the published knowledge of the delta, with an extensive bibliography included at the end of each of the six major sections and also as a single reference for all species of wildlife in the region.

McCart, P.J. 1980. A review of the systematics and ecology of Arctic char, *Salvelinus alpinus*, in the western Arctic. Can. Tech. Rep. Fish. Aquat. Sci. 935: vii + 89 p.

This report is a thorough review of the ecology of Arctic charr over a study area extending from Prudhoe Bay, Alaska to the Mackenzie Delta, Northwest Territories including numerous Beaufort Sea drainages and two tributaries (Big Fish and Rat rivers) of the Mackenzie River. Within the study area, there are two forms of Arctic charr: 1) a western Arctic form which occurs as anadromous and isolated stream resident populations and is

known from only one lake; 2) an eastern Arctic form which only occurs in lakes. Four distinct life history types (lake resident, isolated stream resident, anadromous and residual) are described in terms of its distribution and general life history parameters. The impact of development on Arctic charr populations in the study area is discussed in general terms and some management recommendations are made.

McCart, P., L. Cartier, and H. Bain. 1974. Preliminary studies of primary productivity and other aspects of limnology of two lakes in the Beaufort Sea drainage, Yukon Territory. Chapter VI. Canadian Arctic Gas Study Limited, Alaskan Arctic Gas Study Co. Arctic Gas Biological Report 15: 17 p.

Part of the route of the gas pipeline proposed by Alaskan Arctic Gas Pipeline Company and Canadian Arctic Gas Pipeline Limited crosses the north slopes of Alaska and the Yukon Territory from Prudhoe Bay to the Mackenzie River. The route passes close to, or intersects the drainages of, a number of small lakes. The construction and operation of the pipeline and its ancillary facilities could temporarily affect conditions in some of these lakes. Many of them are spawning, feeding and overwintering areas for important populations of fish including the grayling *(Thymallus arcticus)*, Arctic charr *(Salvelinus alpinus)*, lake trout *(S. namaycush)* and various species of whitefish and ciscoes *(Coregonus sp.)*. At present, there is no detailed published information available describing any of the lakes in the immediate vicinity of the pipeline route on the Yukon North Slope. In order to assess the potential impact of the pipeline on environmental conditions in these lakes it is important to characterize them with respect to such basic parameters as physical and chemical composition, primary productivity and trophic status. This study describes two lakes on the Yukon North Slope, Firth Lake and Lake 105. The study was a preliminary one and was intended, in part, as a test of limnological monitory techniques under rigorous field conditions.

McCart, P., and M. DeBruyn. 1974. Life history of the grayling *(Thymallus arcticus)* in Beaufort Sea drainages in the Yukon Territory. Chapter II. Canadian Arctic Gas Study Limited, Alaskan Arctic Gas Study Co. Arctic Gas Biological Report 15: 41 p.

The grayling *(Thymallus arcticus)*, an important sport fish, is one of the most widely distributed species in the western Arctic. This report describes the distribution and life history of the species in Beaufort Sea drainages of the Yukon Territory. These studies are part of the efforts being expended to determine the ecological impact of the construction and operation of the gas pipeline proposed by Canadian Arctic Gas Study Limited. The studies were conducted through Northern Engineering Services Limited. They were concentrated on streams and lakes along the proposed pipeline route from the Alaska-Yukon border east to the Yukon-Northwest Territories border.

McCart, P.J., and J. Den Beste. 1979. Aquatic resources of the Northwest Territories. Science Advisory Board, Northwest Territories. 54 p.

This report focusses on freshwater fish of the Northwest Territories, their production, utilization for commercial, domestic and sport fisheries, their life histories and management. Northern populations of freshwater fishes are characterized by slow growth, late maturity and long life. The low productivity of fish populations in unexploited areas might not be readily apparent because the numbers and biomass are very high, providing a temporary bonanza to fishermen. The biology of Arctic charr, whitefish and lake trout are described in detail. The authors suggest that cyclic or rotational fishing be investigated as a management tool in the north; maximum sustainable yield in inappropriate.

McLeod, R.H. 1973. A fish marketing study, Northwest Territories. Prepared for Freshwater Fish Marketing Corporation.

This report assesses the market for local fish products within the District of Mackenzie and discusses the feasibility of servicing this market by commercial fisheries. A brief history of fishery development schemes in the Mackenzie Delta, Cambridge Bay and Lac La Marke is outlined. The importance of fish sales from domestic and commercial fisheries is assessed. The inter-relationships between prices, volumes and product mix in respect to their effect on potential markets have been derived and forecasts of market size offered.

McTaggart-Cowan, I. 1976. Cumulative impact of development of the Mackenzie Estuary/ Delta, N.W.T., p. 71-82. In Mackenzie Delta: priorities and alternatives, Conference Proceedings. December 3-4, 1975. Canadian Arctic Resources Committee.

This paper outlines the cumulative impact of development of the Mackenzie Estuary/Delta, the last 100 miles of the Mackenzie River, Northwest Territories, from Point Separation to the Beaufort Sea. This area constitutes the only large estuary/delta opening into the polar seas of North America. Estuaries are extremely productive biologically, actively producing nutrients, vegetation and large populations of a variety of birds and mammals. Concern is that proposed developments, pipelines, gas treatment plants, pumping and refrigeration stations, a major all-weather highway and related industrial social infrastructure requirements will have unknown consequences. These effects will be especially significant for the renewable resources of the natural environment including fisheries, birds, mammals, timber, water and land in its natural state. Impacts will stem from pollution, disturbance, overkill of wildlife and increased access, attributable in large to development of the area for oil and gas exploitation. Seen as a system, complex interrelationships within the environment of the estuary make identification of deep-seated changes due to development difficulties, if not impossible to identify or predict. The totality of the developments

proposed will alter the estuary and its living components (social and environmental changes) profoundly and irreversibly. The author calls for future-looking comprehensive plans for land use, a plan based on good land capability studies and scheduling of development. Past performance gives little evidence of honest concern for maintaining renewable resources.

Milne, A.R. 1976. Canadian environmental studies of the southern Beaufort Sea, p. 87-94. *In* Assessment of the Arctic marine environment: selected topics. Univ. Alaska, Inst. Mar. Sci. Occas. Publ. 4.

This paper was presented at a symposium held in conjunction with Third International Conference on Port and Ocean Engineering under Arctic Conditions, POAC-75. The Beaufort Sea Project began as a collection of 29 studies of the environment of the Beaufort Sea. The program attempts to relate its recommendations on issues concerning offshore oil exploratory drilling and its threat to the marine environment. The project includes baseline studies of phytoplankton and benthic communities, of fish, seabirds and mammals, as well as related biological research on marine ecosystems. These latter studies include the effects of crude oil on ringed seals, on invertebrates and on the bottom organisms responsible for nitrogen fixing. The possibilities of biodegradation of oil are also examined. Baseline studies on existing pollutants include beach walking to determine the status of shoreline debris, tar balls and oil seeps, and include sampling of the sea for dissolved petroleum and hydrocarbons. Also important to consider are the needs of the indigenous human predators regarding the cropping of marine wildlife. Physical oceanographic studies include those on surface and bottom currents, Mackenzie River flow effects on the Beaufort Sea, identification of water masses and their movements and storm surges. Climatology studies include those on the atmosphere, wind, waves and ice. A major meteorological study is concerned with the predictability of weather, wind, waves and ice motion based on the utilization of a small area computerized prediction system. The sea bottom is being selectively examined for sub-bottom frozen materials and for scouring by sea ice. Two oil related geological studies are on the dispersal of Mackenzie River sediments and on coastal sedimentary processes. There are major studies on interactions of oil and sea ice and on oil countermeasures.

Mutch, R.A., and P.J. McCart. 1974. Springs within the northern Yukon drainage system (Beaufort Sea drainage). Chapter IX. Canadian Arctic Gas Study Limited, Alaskan Arctic Gas Study Co. Arctic Gas Biological Report 15: 36 p.

In fisheries studies sponsored by Canadian Arctic Gas Study Limited, a great deal of effort has been expended in locating groundwater sources in streams. These areas are frequently critical to fish populations which use them as spawning and overwintering sites. This aspect of the biology of northern fish populations has been considered in some detail in previous reports. All of the springs discussed in this report support populations of Arctic charr *(Salvelinus alpinus)*. However, the report itself is concerned with the characteristics of springs other than biological ones. In part, it is intended as an introduction to the subject for individuals not otherwise familiar with the study of groundwater and springs. It also includes brief descriptions of the geological, physical and chemical characteristics of a number of springs in the vicinity of the pipeline route in the northern Yukon drainage basin. The areas described in this report lie within Canada's northern hydrological region which includes all of Canada within the continuous permafrost zone.

Olesh, G. 1979. Western Arctic resource evolution. Prepared for Inuvialuit Development Corporation (I.D.C.) by Foodwest Resource Consultants. 169 p.

This feasibility study was conducted in response to the request of Inuvialuit Development Corporation which has interests in developing a commercial whitefish market in the Mackenzie Delta area. Historical data on domestic and commercial fisheries (1960 to present) and major settlements are presented, along with forecasted cost estimates of the proposed development. Data on numerical abundance of fish are presented for Aklavik, Arctic Red River, Fort McPherson, Norman Wells and Fort Simpson as well as the Mackenzie Delta coastline. Seasonal changes in gill net catches are presented for fish species at the sample sites. Fish distributions and relationships for broad and humpback whitefish, inconnu, least cisco, Arctic cisco, boreal smelt and fourhorn sculpin are presented for the delta and outer coastal regions. Fish numbers are recorded for sampling sites in Kugmallit Bay and Tuktoyaktuk Harbour.

Percy, R. 1975. Fishes of the outer Mackenzie Delta. Dep. Environment, Beaufort Sea Project, Technical Report B: 114 p.

Baseline information was gathered in 1974 and 1975 on 23 species of freshwater, anadromous and marine fishes in the outer Mackenzie Delta and nearshore Beaufort Sea. The biological data presented include numerical abundance, summer and winter distributions, nursery areas, food habits, migration and age-length relationships. The possible impact of offshore exploratory drilling to the fish resources is discussed. Although the major impact would arise from an oil well blowout, the cumulative effects of other disturbance factors, such as seismic activity, disposal of drilling fluids and "housekeeping waters" will also be significant over the long term. An effective program of monitoring studies for the renewable resources is essential to facilitate the identification and resolution of potentially dangerous environmental problems at the earliest possible stage.

Percy, R., W. Eddy, and D. Munro. 1974. Anadromous and freshwater fish of the outer Mackenzie Delta. Interim Report of the Beaufort Sea Project Study B2. 51 p.

Numerical abundance, per cent composition and distributions are described for 23 fish species of the outer Mackenzie River Delta and nearshore Beaufort Sea. Boreal smelt, fourhorn sculpin, Arctic cisco and Arctic flounder were taken at offshore locations. Saffron cod and Pacific herring were netted in lagoons along the northeast coast of Richards Island. Least cisco, inconnu, lake trout, burbot, broad, and humpback whitefish were distributed throughout the outer delta and in brackish water. Most species (northern pike, longnose sucker, round whitefish, ninespine stickleback, Arctic lamprey, Arctic grayling, trout-perch, spoonhead sculpin, pond smelt, and lake chub) were found within lakes and channels of the delta. Age-length relationships are presented for boreal smelt, humpback and broad whitefish, inconnu, Arctic and least cisco and fourhorn sculpins.

Pick, A.R. 1978. Proceedings of the AMOP technical seminar, March 15-17, 1978. Environmental Emergency Branch, Environmental Protection Service, Environment Canada. 259 p.

This seminar was organized to provide a forum for AMOP contractors to present reviews and results of their studies to those who have an interest in the future of the program. The objectives of the seminar were to facilitate communications amongst the various groups interested in AMOP and to generate ideas for the planning of the 1978-1979 program. The Arctic Marine Oil Spill Program (AMOP) was approved by the Government of Canada in December, 1976, as a five-year, seven million dollar technology program to develop oil spill countermeasures for arctic waters. Funding for fiscal year 1977-1978 was set at $1.685 million. Work in 1977 was undertaken by about two dozen contractors. The firm of James F. Maclaren Limited was engaged by Supply and Services Canada on behalf of Fisheries and Environment Canada to plan and manage the seminar.

Renewable Resources Consulting Services Limited. 1978. Environmental review and assessment. Proposed Mackenzie River dredging project. Vol. 2 Part 6. Fish (B. Walton and G. Ash): p.299-561. Public Works of Canada and Department of Transport.

The first aspect of the report is a detailed review of fish in the Mackenzie River and its tributaries. Those reaches of the Mackenzie River which will be affected by the proposed dredging program are described in detail as well as the major fish species within each reach (Arctic grayling, northern pike, walleye, longnose sucker, white sucker, inconnu, broad and humpback whitefish, Arctic and least cisco, burbot). Spawning, nursery, summer feeding and overwintering habitats are described. There is a general discussion of the effects of sedimentation on aquatic resources. Fishery resources and impacts are described for each reach.

The second aspect of the report is a field study of fish habitats adjacent to specific dredging alignments on the Mackenzie River from Great Slave Lake to the Mackenzie River Delta. In addition, spawning, rearing, feeding, over-wintering areas and other habitats were analyzed for the major species in the study area. Emphasis was placed on Arctic grayling and Arctic cisco.

Science Advisory Board of the Northwest Territories. 1980. Fish, fur and game of the Northwest Territories. Report No. 2 to the legislative assembly of the Northwest Territories. 40 p.

The potential production, harvests and management needs are outlined for fish, fur and game of the Northwest Territories. This abstract focusses solely on fish.

Each year, 3.9 million pounds of fish of the 5.9 million pound commercial quota are netted annually. It is estimated that the commercial quota could be increased to 16 million pounds. It is also recommended that Arctic charr be introduced into more productive southern lakes in an experiment to determine the possibility of culturing the species. Moreover, the Freshwater Fish Marketing Ordinance should be changed to allow local merchants to purchase fish directly from producers operating certified plants. Although the Beaufort Sea has a 1.3 million pound fish quota, no attempts have been made to exploit the stock.

Slaney, F.F. and Company Limited. 1973. Interim report, 1972 environmental field program Taglu-Richards Island, Mackenzie Delta, Part 4. Aquatic Systems. 1972 Environmental Field Program Taglu-Richards Island, Mackenzie Delta. 100 p.

This is part four of a seven part report on the 1972 environmental program carried out by F.F. Slaney (Vancouver) on Taglu-Richards Island area, Mackenzie Delta. This part deals with aquatic systems in the Delta area. The purpose of the aquatic systems survey was to provide inventory data on the lake, channel and estuarine ecosystems within the study area. Data were obtained using standard limnological and oceanographic techniques. A total of 26 fish species were recorded from the lakes, channels, and estuarine waters of the study area. Catches consisted primarily of coregonids with Arctic cisco, least cisco, humpback whitefish and inconnu being common. Stomach analysis of captured fish showed that certain species utilize a wide spectrum of food resources. However, crustaceans and molluscs appear to be staple food items. Differences in physical, chemical and biological characteristics indicate that at least four lake types occur in the study area: tundra, channel, salt and high lakes. They are described. The hydrologic conditions in Mackenzie Bay were variable, being directly influenced by wind direction, wind velocity and Mackenzie River outflow. Water from the river dominated the bay in July, followed in August by a saltwater intrustion along the bottom. As the river discharge lessened in September, an increasing proportion of the bay was comprised of Beaufort Sea water. Approximately 1 750 beluga were observed moving through Mackenzie Bay from June to August, 1972. The bay appeared to be utilized immediately after the calving period, because of the warmer Mackenzie River flow.

Slaney, F.F. and Company Limited. 1974. Impact Assessment. 1972-1974 Environmental Program, Mackenzie Delta, Northwest Territories 9: 401 p.

The report serves to abstract information and assess environmental impact contained in following volumes of the program. The purpose of the program is to predict physical, biotic and resource impact in the Mackenzie Delta area of the N.W.T. Subjects of study are meteorology and climatology, hydrology, landforms, vegetation, birds, mammals, aquatic resources and environmental quality. Existing environmental conditions, present patterns of resourse use, effects on the environment, effects upon human use of resources and implications of environmental effects are examined. Additional considerations and a summary of principal conclusions are also presented.

Slaney, F.F. and Company Limited. 1975. 1974 summer environmental program Mackenzie River estuary. Vol. 1 - Aquatic studies. 156 p.

This report, Aquatic Studies, is volume 1 of a three volume report series dealing with studies undertaken during the 1974 summer environmental program in the Mackenzie Estuary. Other titles in the series include "Terrestrial Studies" (volume 2) and "Marine Mammal Studies" (volume 3). Each report Volume contains common introductory sections which outline the work undertaken and the study areas involved so that individual volumes are independent and can be read separately. These multidisciplinary studies were designed to assess the effects upon the environment of artificial island construction undertaken by Imperial Oil Limited and Sun Oil Limited during 1974. The study area is immediately offshore of the east central portion of the Mackenzie Delta. This report provides an assessment of the effects upon physical oceanography (ice, winds, sea storms, waves and currents), water chemistry (salinity, temperature, turbidity, dissolved oxygen, hardness, alkalinity, nutrients and heavy metals), zooplankton and phytoplankton, benthos (inventory, distribution, seasonal variation and importance studies) and fish arising from summer construction of offshore islands in east Mackenzie Bay. From the broad information base established by the 1974 summer environmental program, together with previous studies, the effects related to most development activities were judged to be of short duration and of local influence. The information gathered will be of value in describing the implications of future island development and use, and could aid in environmentally safe design and scheduling of future operations.

Slaney, F.F. and Company. 1976. 1975 Fisheries and water chemistry survey, Big Horn Point, Richards Island, N.W.T. Prepared for Beaufort Gas Project, Imperial Oil Ltd. 16 p. + appendices.

This study was initiated to provide background fisheries, hydrological and water quality data necessary to assess the potential effects of dredging silt and granular materials from Harry Channel in the Mackenzie Delta.

The four sampling periods during the 1975 open-water season were June 12-22, July 8-9, August 15-17 and September 26-29. It is suggested that coregonid fry move downstream to the Mackenzie River estuary after ice break-up using Harry Channel as a migration route. Peak coregonid fry catches were during July 9-10. Humpback (lake) whitefish, broad whitefish, inconnu and ninespine sticklebacks were caught in larger numbers in August than in any other sampling period. September catches indicate that mature males and ripe females utilize Harry Channel as an upstream migration route. It is suggested that dredging Harry Channel soon after ice break-up would have the least effect on fish species.

A discussion of hydrology and water chemistry analyses was not presented in this report. Results of these data are presented in tabular form.

Slaney, F.F. and Company Limited. 1976. Summer environmental program. Mackenzie River Estuary. Vol. 1. Aquatic Studies. Prepared for Imperial Oil Ltd. Calgary. 152 p.

The objective of this study was to supplement existing data for the assessment of environmental effects in relation to summer artificial island construction in East Mackenzie Bay by Imperial Oil and to provide baseline bio-physical data at selected sites identified within the Mackenzie estuary. Although the study dealt with oceanography, plankton, benthos and fish, this abstract focusses on the fisheries.

Within the coastal waters of the Mackenzie Delta, 25 species of freshwater, anadromous and marine fishes were collected. Fish diversity and abundance was greatest in estuarine embayments on Richards Island and along the shorelines of Barrier Islands, particularly the northern tip of Pelly Island, Hooper Island and Pullen Island. Anadromous fish species including least cisco, Arctic cisco and boreal smelt were widely distributed throughout the coastal waters. Least cisco, boreal smelt, arctic cisco and fourhorn sculpin represented 81% and 76% of the catch in 1974 and 1975, respectively. Broad whitefish, humpback whitefish and inconnu remained close to channel and river mouths.

Young-of-the-year whitefish were taken in low numbers in the nearshore of the Barrier Islands.

The lack of ripe or spent fish being collected during two years of intensive summer surveys along the coastal reaches of East Mackenzie Bay, strongly suggests that this region does not serve as a spawning ground during the ice-free period. The coastal waters of East Mackenzie Bay are important feeding and rearing areas for anadromous species such as Arctic cisco, least cisco, and boreal smelt. Marine species include fourhorn sculpin and Arctic flounder.

Slaney, F.F. and Company Limited. 1976. 1975 Hydrological survey. Taglu, Richards Island, Mackenzie Delta, Northwest Territories. Prepared for Beaufort Gas Project, Imperial Oil Limited, Calgary, Canada. 53 p. + appendices.

This study was initiated in 1975 to supplement existing hydrological data for Taglu, Richards Island by collecting additional data on

water level, discharge, flooding, bathymetric water chemistry and ice characteristics. In April, 1975, ice thickness was variable varying from 1.5 to 1.8 m (depending on amount of snow cover). Free-flowing water was evident beneath ice cover on Harry and Kuluarpak channels. Water temperature was -0.2°C to -0.3°C. Dissolved oxygen was 13.2 mg/L, near saturation, providing ideal over-wintering conditions for fish species. Turbidities were ≤ 5 ppm. total dissolved solids were ≤ 266 ppm and total suspended matter was ≤ 30 ppm.

Ice break-up occurred each June and soon after peak channel water levels and discharges resulted. Suspended materials, settleable materials and turbidities attained peak levels at this time. During the summer, water levels gradually decreased along with corresponding decreases in turbidity levels on the two channels. Water temperatures reached 15°C to 19°C and oxygen levels varied from 9 to 11 mg/L. Complete freeze-up of channels occurred in mid-October.

Slaney, F.F. and Company Limited. 1977. 1976 Summer aquatic studies Arnak L-30. Artificial island site and Tuft Point Borrow Site. Prepared for Imperial Oil Ltd., Calgary.

The purpose of this study was to conduct a bio-physical program of aquatic studies at the Arnak L-30 artificial beach site before, during, and after island construction to examine the effects of environmental perturbations associated with uncontained hydraulic fill activities. The artifical island located east of Pullen Island and northwest of Kugmallik Bay was approximately 385 m across and 1.6 m high. A concurrent bio-physical overview was conducted at the Tuft Point borrow area to identify environmental concerns resulting from continuous gravel extraction.

In the long-term, construction of Arnak L-30 did not result in any major impact on the physical-chemical oceanography of the area. In the short-term, the physical-chemical oceanographic environment changed over an area up to 5 km from the island. No significant adverse effects on surface phytoplankton communities were noted. The surface phytoplankton data cannot be extrapolated to greater depths where effects of dredge-created turbidity plumes would be greater. There were marked increases in grazing rates of plankton within the Arnak turbidity plume. The most significant impact to invertebrates occurred from the physical burial and removal of invertebrate fauna during on-site dredging. The fish community in the vicinity of Arnak L-30 was comprised of four species: Pacific herring *(Clupea harengus pallasi)*, Arctic cisco *(Coregonus autumnalis)*, least cisco *(Coregonus sardinella)* and fourhorn sculpin *(Myoxocephalus quadricornis)*. Gillnetting catch per unit effort during August 1976 varied from 0.023 to 0.186 fish caught per hour, significantly less than that reported by Poulin for inshore freshwater stations. Significant data on effects of island construction on fish communities were not obtained.

Results from the 1976 sampling program of July and September during the dredging program at the Tuft Point area showed that levels of most oceanographic parameters, except turbidity and suspended materials were within similar ranges to those found in previous years in Mackenzie and Kugmallit Bays. Rates of phytoplankton production were significantly reduced within the turbidity-plume. Least cisco were the most dominant fish species, by number, at the Tuft Point sample site. Since juvenile coregonids were taken at the sample area, it is suggested that the site be used for rearing and feeding by this species.

Smith, A.R., and G.M. Bradley. 1974. 1972-1974 Environmental program, Mackenzie Delta, Northwest Territories. Vol. 6 - Aquatic resources. F.F. Slaney and Company Limited. 191 p.

The primary purpose of the program was to describe the channel, stream and lake ecosystems of the Mackenzie Delta study region through surveys carried out over a two year period. Preliminary studies were also carried out in the east Mackenzie Bay. The specific objectives of the survey were: to identify aquatic vertebrates and invertebrates and learn of their distribution, to describe basic physical and chemical parameters of aquatic habitat and to identify aquatic resource use by people of the region. The program varied in scope from 1972 to 1973. In 1972 the immediate offshore area as well as most of Taglu-Richards Island were studied. In 1973 the Parsons Lake area, the Numak-Niglingtak area and connecting corridors were included.

Stein, J.N., C.S. Jessop, T.R. Porter, and K.T.J. Chang-Kue. 1973. An evaluation of the fish resources of the Mackenzie River Valley as related to pipeline development. Vol I. Task Force on Northern Oil Development, Environmental Social Committee Northern Pipelines Report 73-1: 121 p.

This study is the second year of a proposed four year investigation into effects of pipeline construction on fish resources of the Mackenzie Valley. In addition to base camps established at Arctic Red River, Norman Wells and Fort Simpson during 1971, additional camps were set up in the delta region at Aklavik, Fort McPherson and on the Rat and Rabbitskin rivers.

Of the 34 fish species in the Mackenzie River system Arctic charr, lake trout, inconnu, humpback and broad whitefish, Arctic and least cisco, walleye and Arctic grayling would be most affected by pipeline construction.

Species composition, length-weight relationships, age and growth characteristics and food habits were determined for the common fishes. Migration routes and times, spawning characteristics and nursery areas were also investigated.

Stein, J.N., C.S. Jessop, T.R. Porter, and K.T.J. Chang-Kue. 1973. Fish resources of the Mackenzie River Valley. Interim Report II. Task Force on Northern Oil Development, Environmental Social Committee Northern Pipelines. 260 p.

Biological data are presented for the most abundant fish species of the Mackenzie River based on data from 1971 and 1972. Northern distributional ranges were extended for mountain whitefish, lake cisco, northern redbelly dace, spottail shiner, brook stickleback and goldeye.

Age-length relationships and food habits of major species are described.

Migration routes and spawning habits are described for several species. Inconnu, whitefish and cisco species migrate upstream through the delta channels between August and October to spawn in large upstream tributaries during September and October. Arctic charr move through the western delta to spawn in Big Fish and Rat River systems during September and October.

Clear tributaries are important nursery areas for walleye, Arctic grayling, Arctic charr and burbot. Nursery areas for whitefish, cisco, longnose sucker and northern pike range from clear to turbid.

Task Force on Fisheries Development. 1972. Where to now? Fisheries development in the Northwest Territories. Report of the federal-territorial task force, Yellowknife, N.W.T. Vol. I & II.

Although relatively large populations of fish have been discovered in some areas of the Northwest Territories, little work has been done to assess the productivity and sustainable yield of the fisheries. The main objectives of the task force were to prepare a proposal for the development of freshwater, marine and anadromous fishery resources for the period, 1972-1977, and to develop a continuing management system. The task force supports the principle that northern development should benefit northerners. Domestic fisheries should have priority over commercial and sport fisheries.

Many northern fish stocks are too isolated and unproductive to support a viable commericial fishery based on export to southern markets. Although northern fishes have a high standing stock, their rate of production is low. Sport fishery operations should be based on the harvests of trophy-sized fish. The Mackenzie Delta is one of four areas which may have potential for a commercial fishery with careful planning and under controlled development.

Usher, P.J. 1975. Historical statistics approximating fur, fish and game harvests within Inuit lands of the Northwest Territories and Yukon 1915-1974, with text. Inuit Tapirisat of Canada. Renewable Resources Project. Vol. 3: 71 p. + appendix.

Historical statistics approximating harvests for 24 economic species of fur, fish and game are presented for 30 geographic districts within the traditional Inuit lands of the Northwest Territories and the Yukon. The series begins for some taxa as early as 1915 and continues to 1974. Fish represent a minor component of this report (no taxonomic levels are distinguished). Data for fish were derived from Area Economic Survey Reports and other cited literature. These fish data are of uncertain reliability.

Withler, R.E. 1976. A review of the literature concerning domestic fisheries associated with proposed gas pipeline route in the Mackenzie River valley. A report by Aquatic Environments Limited for Canadian Arctic Gas Study Limited. 38 p.

This report is a summary of available information on the domestic fisheries of the lower Mackenzie region and Delta, Fort McPherson and Arctic Red River, central Mackenzie region and upper Mackenzie region. Although changes in domestic fish catches may be quite dramatic, the trends are not obvious especially in data from the delta.

Wong, C.S., W.J. Cretney, P. Christensen, and R.W. MacDonald. 1976. Hydrocarbon levels in the marine environment of the southern Beaufort Sea. Dep. Environment, Beaufort Sea Project, Technical Report 38: 113 p.

This report summarizes the activities and results of the hydrocarbon baseline studies in the southern Beaufort Sea during the summer of 1974 and 1975. The investigation sought to 1) establish the baseline hydrocarbon levels in the southern Beaufort Sea drilling area by measuring classes of hydrocarbons and identifying some specific hydrocarbons in sea water, marine organisms, fish and surface sediments, 2) assess the origin of present-day hydrocarbons, and 3) understand the probable hydrocarbon pathways in case an oil spill or blowout occurs in the area. Results include polycyclic aromatic hydrocarbons and low molecular weight hydrocarbons in sea water, polycyclic aromatic hydrocarbons and nonpolar hydrocarbons in fish, mixed plankton and sediments.

Wong, C.S., D. MacDonald, and W.J. Cretney. 1976. Distribution of tar and other particulate pollutants along the Beaufort Sea coast. Dep. Environment, Beaufort Sea Project, Technical Report, Publ. 13: 96 p.

This report summarizes the objectives of the project, the study area, methods, sources of data and field and laboratory results of the investigation during the summers of 1974 and 1975 along the Beaufort Sea coast. The objectives of the study are: 1) to establish the baseline distribution of particulate pollutants, especially for tar and plastics, in the present-day Beaufort Sea marine environment, 2) to establish areas with natural seepage of crude oil and 3) to establish the chemical characteristics of hydrocarbons in the present day beach sediments, nearshore sediment and marine organisms, including fish. The study area in 1974 covered the S.W. coast of Mackenzie Bay and portions of the western coast of Tuktoyaktuk peninsula. In 1975 the area was expanded to include not only the Yukon coast, but also some of the offshore islands of the Mackenzie River delta and a larger portion of Tuktoyaktuk peninsula. No extensive tar pollution was found and no natural seepage was evident, although some isolated occurrences of asphalt near Drift Point and grease near Shingle Point and around Tuft Point and Warren Point were encountered. However, plastic wastes, in particular explosive cannister fragments originating from marine seismic activities, were prevalent and were found to have reinundated beaches that had been cleaned up during the 1974 survey. Beach sediment, nearshore sediment and fish samples were collected to establish their hydrocarbon characteristics.

Wright, D.G. 1979. A plan for scientific response to an oil spill in the Beaufort Sea, p. 525-532. *In* Proceedings, 1979 Oil Spill Conference March 19-22. Los Angeles Conference. American Petroleum Inst.

This paper was presented at the 1979 Oil Spill Conference, (prevention, behavior, control, cleanup) held in Los Angeles, California, March 19-22, 1979. Exploratory drilling for hydrocarbons under the continental shelf of the Canadian sector of the Beaufort Sea has been actively pursued since 1973. There is a significant probability that at least one major oil spill may occur in this area during the course of exploration and exploitation. It has been demonstrated on previous occasions that an ad hoc approach to studies at the site of a major oil spill results both in major gaps in the information obtained and in inefficient utilization of available logistic resources. In anticipation that a major oil spill could occur in the Beaufort Sea, a scientific response plan has been developed. The plan consists of 28 integrated scientific studies that would be conducted to assess the immediate impact of such a spill, to provide a base for the assessment of the long-term impact of the spill and to increase the knowledge (and hence predictive capabilities) concerning the behaviour and fate of oil in arctic marine environments. Thirteen of the studies are concerned with determining the behaviour and fate of the spilled oil, and fifteen are concerned with determining the biological impacts. Memoranda of agreement to participate in the implementation of the plan have been signed by the participating agencies. Funding for the plan is being sought from the Canadian Treasury Board in a special two-part submission. Phase I of the submission seeks immediate funding to purchase and stockpile necessary equipment and materials; phase II requests a guarantee that funds will be made available to implement the response plan, should it ever be necessary. Coordination of the Beaufort Sea Scientific Response Plan is the responsibility of Fisheries and Environment Canada, Fisheries and Marine Service.

Zoltai, S.C., R.P. Baldwin, R. Edwards, J.N. Stein, B. Janz, and A.S. Goodman. 1975. Assessment of the proposed Fort Simpson and Cross-Delta relocations of the CAGPL pipeline. Dep. Environment, Task Force on Mackenzie Valley Pipeline Applications. 9 p.

Several amendments and supplements were submitted by the Canadian Arctic Gas Pipelines Limited since the submission of the original application to build a gas pipeline in the Mackenzie Valley. These amendments were examined by the Department of Environment Regional Task Force on Mackenzie Valley Pipeline Applications. The Task Force feels that the Cross-Delta realignment is favourable to reducing the environmental impact of construction but some new difficulties will be encountered by the new routing. The major concern involved in the rerouting is its effect on critical aquatic habits which cover much of the Delta. Specifically the Task Force is concerned with the construction scheduling of major water crossings, impediments with fish migration and destruction of fish habitation. The Task Force recommends winter construction, rigid control of excavation, backfilling and cleanup operations in the delta channels, extensive monitoring of fish migrations through the construction area and rerouting to avoid lakes used for overwintering by fish. In addition to disturbances of aquatic ecosystems, the rerouting may disturb snow geese, peregrine falcons and grizzly bears. Route changes are suggested to avoid that Canadian Arctic Gas Pipelines provide information on waste disposal, water, air and land pollution with reference to the conditions that prevail on the Mackenzie Delta.

DOCUMENTATION OF UNPUBLISHED INFORMATION

Most available literature on fisheries in the study area has been prepared by consultants or government biologists. Much of the data on fish harvests in the areas has been obtained through unpublished manuscripts and government files in Winnipeg, Yellowknife, and Inuvik. Several days were spent in Inuvik perusing all the files in the DFO sub-district office. Table 4 lists the information sources for data used in this report.

COMMERCIAL, DOMESTIC, AND SPORT FISHERIES

The Federal-Territorial Task Force on Fisheries Development (1972) recommended that the domestic fish needs of indigenous people be met before the needs of commercial or sport fishermen. This philosophy is still maintained by the Federal and Territorial governments.

At present, commercial and sport fishing licenses are required for all fishermen within the NWT (residents under 16 years and over 65 years do not require a sport fishing license). Although non-natives may be issued a domestic license, indigenous people do not require licenses for subsistence (domestic) fishing. Natives wishing to catch fish for purposes of sale must, however, purchase a commercial license.

Summer, fall, and winter are the three major fishing seasons (Hunter 1975). The summer fishery extends from mid-June, after ice break-up, to mid-September. During late September and October, major runs of migratory fish are harvested. The winter fishery, depending on ice thickness, usually extends from November to January.

COMMERCIAL FISHERIES

Commercial fishing is the harvest of fish for export markets or local sale. The Freshwater Fish Marketing Corporation (FFMC), a federal crown corporation established in 1969, has an exclusive mandate for marketing all fish exported from the NWT, northwestern Ontario, Manitoba, Saskatchewan, and Alberta (Fig. 6)(Cauvin 1979). In the Northwest Territories, the price set for fish products has often been less than the operational and transportation costs of delivering fish to the FFMC market (Barlishen and Webber 1973). The Task Force on Fisheries Development (1972) suggests that, within the Northwest Territories, the more northern fish stocks are too isolated and

unproductive to support a viable commercial fishery competitive with the product of southern fisheries in Great Slave Lake, Lake Winnipeg, or the Great Lakes.

Species, mesh sizes, closed seasons, and quotas for NWT commercial fishing are reported in Schedule V of the NWT Fishery Regulations (Fisheries and Environment Canada 1977). The purpose of a commercial fish harvest quota is to provide fishermen with a reasonable catch while preventing over-fishing. If possible, when a fisherman requests permission to fish commercially in a previously unexploited area, a test fishery is conducted (guidelines: Kristofferson and McGowan 1981). If a test fishery is not conducted, quotas may be set on the basis of trial and error (experimental management), or on the 0.5 lb/acre/yr (0.56 kg/ha/yr) rule developed by Rawson (1960) for more temperate lakes. Although management personnel realize that this latter formula is not totally satisfactory, no other alternatives are available, primarily due to the large number of waterbodies for which quotas must be established. Often insufficient time is available to base quotas on the results of the test fishery and frequently insufficient funds are available to continue a monitoring program in the area for future re-evaluation. Although the DFO is responsible for conducting test fisheries, territorial wildlife officers have also collected significant amounts of data that have been useful to the program.

Of the established commercial fishing areas within the NWT (Fig. 7), the Mackenzie Delta, Cambridge Bay, and the Hornaday River have been the three main centres for commercial fishing in the study area.

Barlishen and Webber (1973), McLeod (1973), and Olesh (1979) record the development of commercial fishing in the Mackenzie Delta (Table 5). Broad whitefish *(Coregonus nasus)* continues to be the major commercial fish species in the Delta region. Data from a fence monitoring program on Kukjuktuk Creek in 1979 indicate that by freezeup on 29 September 1980, 140 692 anadromous broad whitefish ($\geq$ 200 mm fork length) had entered the creek (Chang-Kue, personal communication), and these fish likely originated from the east channel of the Delta. An additional 1 027 750 broad whitefish (< 200 mm fork length) had also migrated upstream by that date. Many of these fish were juveniles and thus likely subject to high mortality before attaining a harvestable size.

Recently, funds have become available from the General Development Agreement (a joint Federal-Territorial program for the economic development of renewable resources in the NWT) to conduct a one year experimental commercial fishery in the Mackenzie Delta. If a commercial fishery is re-established, the recently completed Dempster Highway would facilitate transportation of fish products to other markets.

There are existing domestic and commercial fisheries along the west side of the Mackenzie Delta conducted primarily by the residents of Aklavik and Fort McPherson. There is some indication that this fishery may have adversely affected Arctic charr populations in the Fish and Rat rivers which have a smaller average size (1.5 to 2.0 lb) than is usual for populations of this species.

The total fish harvest (commercial, domestic, and sport) from the Hornaday River, to the east of the Mackenzie Delta, may double the assigned commercial quota of 15 000 lb (total harvest 1977: 31 665 lb; R.T. Barnes, personal communication). Test fisheries were conducted on this river in 1973, 1974, and 1978. While the data are not conclusive, it does appear that there were fewer large fish in the latter year (Memorandum from A.H. Kristofferson to R.T. Barnes, 23 March 1979).

The history of the Cambridge Bay fishery has been discribed by several workers (Bissett 1967; Barlishen and Webber 1973; Kristofferson and Carder 1980). The Cambridge Bay Arctic charr fishery, established in 1960, is operated by the Ekaloktotiak Eskimo Co-operative. The government of the Northwest Territories (GNWT) owns the processing plant which it leases to the co-operative. Kristofferson and Carder (1980) have tabulated the production of the anadromous Arctic charr from 1960-1978 (Table 6).

Fourhorn sculpin dominate the Beaufort Sea marine catch but commercial interests have focused on the more marketable Pacific herring *(Clupea harengus)*. Despite the unsuccessful experimental fishery in 1963 (Bissett 1967), recent interest has dwelt on the possibility of a herring roe industry.

Pacific herring in mature and post-spawning condition occur in spring and fall runs along the Tuktoyaktuk Peninsula, Mason Bay, and Kugmallit Bay (Riske 1960; Hunter 1975; Percy 1975; Byers and Kashino 1980) where, however, they usually constitute only a small portion of the fish catch. Galbraith and Fraser (1974), in contrast, reported that Pacific herring were the most abundant gillnetted species in Kugmallit Bay. This is a densely schooling species and its distribution would be expected to be variable and patchy.

Commercial Fish Harvests for Export and Local Markets

Data for commercial fish species exported from the entire FFMC region and, in particular, the NWT are summarized in Tables 7 and 8, respectively. Total fish harvests for specific waterbodies within the Mackenzie Delta (Region 1) and Central Arctic (Region 4) are presented in Tables 9 and 10. The commercial fisheries region for the Delta extends to the south shore of Great Bear Lake (Fig. 5).

Export harvests from the Delta (0.44 and 0.23%) and the Central Arctic (4.42 and 2.35%) for 1977 and 1978 are a minor component of the total NWT commercial export harvest (Tables 9 and 10). The Great Slave lake whitefish fishery is the major contributor to the commercial export harvest in the NWT.

In Table 11, seasonal harvests are recorded

for Cambridge Bay, Gjoa Haven, and Pelly Bay for the years 1974/75 to 1978/79. Arctic charr was the most dominant species harvested in these coastal communities. Cambridge Bay was the major fishery with harvests of 170 190 lb in 1977/78 and 125 640 lb in 1978/79 (Table 11).

Table 12 is a 25-year summary (1955-1980) of commercial fish exports from the Mackenzie Delta. During 1967 to 1971, no commercial fishery operated in the area and no fish exports were recorded. Based on DFO records (Yellowknife), the maximum commercial fish harvest (105 625 lb) was recorded in 1963. Although 77 354 lb of fish were harvested, 34 904 lb of the catch were culled (i.e. wasted or rejected due to poor quality). Historical records indicate a disagreement concerning the year of maximum fish harvest: Bissett (1967) indicates that 77 354 lb were taken in 1964, not in 1963 as indicated in the DFO Yellowknife records.

Prior to 1977, there were no consistent records for locally sold fish harvested from the Delta region (Fig. 8). During 1977, fishery officers from Inuvik (DFO) began to interview fishermen in local communities. In 1978, fishery data request forms were sent to licensed commercial fishermen in the region, but the response was poor (N=25). In succeeding years, however, response improved: 1979 (N=58), 1980 (N=71). During the last two years, request forms were revised improving their clarity, reminder letters were sent, and interviews were conducted both by fishery officers and representatives of the Hunters and Trappers Association (HTA). During the period 1978 to 1980, Arctic charr and broad whitefish were the two most common locally sold fish species (Tables 13, 14, and 15). Each licensed fisherman sold an average of 871 lb, 784 lb, and 242 lb of fish (round weight) in local communities during the years 1978, 1979, 1980, respectively. Few Arctic charr were harvested for local sales in 1980, hence the lower harvest figure for this year compared with previous years.

While the response forms do provide useful information, caution should be used in interpreting these data:

1. Although fishing locations were not requested on the 1978 forms, many individuals volunteered this information which has been used in constructing Table 13.

2. Since forms are distributed at the end of the fishing season, individuals generally depend on a mental record or guess at the year's catch.

3. Local common names are used: charr, trout, whitefish, crooked backs, inconnu, herring, grayling, burbot, pike, salmon, and suckers. In Tables 13 to 15, these common names have been replaced with scientific names. Herring includes Arctic and least cisco, not Pacific herring (*Clupea harengus*). Thus, misinterpretation and misidentification of species may occur.

4. Both numbers and pounds of fish caught were requested in the 1977 and 1978 request forms. In 1980, only numbers of fish were requested and recorded weights in the tables were based on averages assumed by the fishery officer: 1 fish (excluding herring) = 4 lb: 1 herring = 1 lb.

5. Individuals may underestimate their catches to avoid more rigorous regulations. Whereas waybills are filled with exported fish to the FFMC, individuals may sell fish to a neighbour directly without any record of the transaction.

6. The proportion of culled fish is not known.

Despite these drawbacks, this is the first attempt to catalogue local fish sales in the area and, for that reason, very useful.

DOMESTIC FISHERIES

Domestic or subsistence fishing enables Inuit, Indian, or Metis, using traditional methods, to provide food for themselves, their families, and their dogs (Fenge et al. 1979).

Fishermen from the Delta communities (Aklavik, Arctic Red River, Fort McPherson, Inuvik, Reindeer Station, and Tuktoyaktuk) have established fish camps throughout the Delta, along the Peel and Arctic Red rivers, in Tuktoyaktuk Harbour, and, occasionally, on the Eskimo Lakes (maps of fishing camps are presented in Bissett 1967). In recent years, domestic fishing has proved to be less a necessity; dog teams have been largely replaced by snowmobiles and some fishermen are obtaining employment in local communities.

Due to hazardous sea conditions and lack of suitable equipment, relatively little domestic fishing has been conducted in the Beaufort Sea along the Arctic coastline compared to the Mackenzie Delta (Ferguson 1961).

Mesh size is not regulated for the domestic fishery. Local fishermen have been using consistently smaller mesh nets (than commercial nets) to catch the Rat River Arctic charr run, possible decreasing the mean size of the fish population. Arctic charr are also taken in September at their spawning grounds at the Fish Hole on Cache Creek, a tributary of the Fish River (Hunter 1975).

Many domestic fishermen purchase commercial licenses so that they may sell a portion of their catch to local visitors or merchants. It becomes very difficult to regulate this aspect of commercial fishing, since the catch may have been taken with domestic fishing gear (i.e., often smaller mesh nets).

Broad whitefish, Arctic cisco, inconnu, and burbot are used for human consumption, while humpback whitefish (often heavily parasitized with *Triaenophorus crassus*), northern pike, and suckers are used for dog food. Nets are set in quiet waters and often at the mouths of rivers and streams. During inclement weather, nets not checked for long periods of time (several days) may result in much wasted or culled fish.

Although historical commentaries and estimates of domestic fish catch are available

(Bissett 1967; Jessop et al. 1973; McLeod 1973; Lilley 1975; Withler 1976; Berger 1977), few data are available (Table 16). It is difficult to determine if such estimates are realistic even during the times when natives were more dependent on fish resources.

Hunt (1972) estimated the consumption of fish in the Delta per person (100 lb/year) and per working dog (1 316 lb/year). Utilization figures were then calculated for all communities. Using this technique, Jessop et al. (1974) suggested that the communities of Aklavik and Arctic Red River consumed 334 990 and 120 700 lb, respectively, in 1973.

In 1977, DFO hired local native people to interview fishermen in their respective communities to obtain a more accurate estimate of domestic fish harvests. Few data are available from this survey. From 1978 to 1980, the fishery officer at Inuvik sent fish data request forms to fishermen throughout the Delta. Local interviews were continued. Data from these surveys are presented in Tables 17, 18, and 19. Low harvests in 1978 represent a low response by fishermen to the initial survey. Based on 1979 and 1980 data, about 225 000 to 250 000 lb of fish are harvested annually from the Mackenzie Delta and environs (see earlier comments regarding caution in interpreting these data).

A comparison of domestic fish harvests with local and exported commercial harvests indicates that domestic fish constitute 78-83% of the total catch (Table 20). Thus, attempts to manage fisheries in the Delta through commercial quotas may have little effect on the fish populations. If populations of some fish species (e.g., Arctic charr) continue to be heavily exploited, it may be necessary to regulate these domestic fisheries.

SPORT FISHERIES

The Explorer's Guide (1980) lists 49 hotels, 48 lodges and camps, plus 28 outfitters and naturalist facilities in the NWT. Sport fishing lodges often have a main lodge on a lake, but frequently offer fly-in services to other bodies of water. The summer months are most popular for sport fishing (Table 21). Fenge et al. (1979) report the number of sport fishing licenses issued in the NWT from 1970 to 1976 (Table 22). Lake charr, northern pike, Arctic charr, Arctic grayling, and walleye are the most popular sport fishes (Table 23).

Sport fishing regulations are outlined in Schedule VI of the NWT Fishing Regulations and in the 1980 Explorer's Guide. Sport fishing is to be interpreted as a recreational experience and is not food-oriented. Financial returns to NWT residents may be greater for sport than commercial fishing with less stress on the resource (Task Force on Fisheries Development 1972).

Sport fishing harvest data are very limited. Beginning in 1975 and subsequently at five year intervals, DFO and GNWT (Travel Industry Association) intend to conduct surveys of sport fishing lodges and outfitters in the NWT. A report of the results of the 1975 survey is just being drafted (D. Topolniski, personal communication).

Within the NWT, areas delineated for the recreational fishing (Fig. 9) survey differ from commercial fishing regions (Fig. 5). Thus, unless specific data become available, comparisons of fish harvests are difficult. In 1975, 1 615 licensed anglers fished in recreational fishing area 1, a portion of which includes the study area (Table 24). Area 5, the most popular sport fishing area, includes Great Slave Lake.

The 1980 Explorer's Guide lists six lodges or camps and outfitters in the study area. One outfitter, Beluga Tours, is no longer in operation. We attempted to contact, by telephone, all owners of these facilities to obtain an estimate of sport fish harvested in the Delta region. Although fish harvest records were not kept, some owners were able to estimate the annual angling harvest (Table 25). One operator complained that commercial fishermen entered his angling area to harvest large numbers of fish.

The following areas are popular angling spots for residents of Inuvik: Campbell Creek, Point Lake, Sandy Lake, Sitidgi Lake, Sonotuk Lake, and Stanley Point. Before construction of the Inuvik airport, Airport Lake was one of the few angling locations with road access, but due to airport obstructions, there is no longer a road access to the lake. Lake charr and northern pike are the most popular sport fishes in these waterbodies.

ASSESSMENT OF THE AVAILABLE INFORMATION

This section of the report is an assessment of the strengths and weaknesses, gaps and deficiencies in the available information as related to fishery management requirements describing commercial, sport, and domestic fisheries.

COMMERCIAL FISHERIES

As the information on Table 5 indicates, commercial fisheries in the Mackenzie Delta and along the adjacent portions of the Beaufort Sea coast have been sporadic and generally unsuccessful. The reasons for this are various but include:

- distance from major markets and the consequent high cost of the undelivered product;
- limited local markets;
- undercapitalization and unreliable equipment;
- unskilled maintenance personnel;
- conflicts between domestic and commercial fisheries.

Any number of these might change in future. Probably the economic factors (i.e., those that affect the cost of the product delivered to major southern markets) will prove most attractive but even these might be controlled or eliminated if there is a sufficient subsidy to fishermen, if

larger local markets develop, or if the cost of transportation to southern markets declines. The two latter possibilities are most likely as a consequence of petroleum resource development in the area. This could provide a much increased local market in camps and towns in the study area as well as cheaper back-haul rates for trucks and other forms of transportation supply industry.

Even if, however, the various factors limiting commercial development are overcome, there are still some basic biological problems in managing intensive fisheries.

Anadromous Species

Differentiation of stocks

With regard to the anadromous species which frequent the Delta and adjacent portions of the Beaufort Sea coast, while we have a general idea of their life history patterns, we do not have the level of detail required for sophisticated management. We cannot, for example, distinguish individual stocks of most species, a prerequisite to establishing regulations for the protection of populations subject to intensive fisheries. This is true, for example, of the broad and lake whitefishes, the two species which, because of their high individual value and large numbers, have probably the greatest potential for commercial development. Recent studies suggest that the movements of these fishes are complex and difficult to interpret. Where mixed stocks are fished, it often happens that, because of the timing of location of the fishery, some are fished much more intensively than others. If the study area is to be fished intensively, stock differentiation will be much more important than it is now so that individual stocks can be monitored and regulations adjusted to counter any adverse effects.

Quotas

A related subject is the establishment of quotas. In lakes in the Northwest Territories, quotas have been established either on the basis of 0.5 lb of fish per acre or on the basis of a test fishery procedure which is applied with a varying degree of rigor. Whatever the method, the establishment of quotas for lakes is conceptually simple in comparison with establishing quotas for the study area under discussion here. Anadromous fishes in the Delta and along the coast are highly mobile, often with complex patterns of movements which may differ for juveniles and adults. At any individual location, catches may consist of a mixture of species and stocks and there may be great differences between catches both seasonally and even annually if fish change their migration routes through Delta channels from year to year. No simple determination of catch per unit effort or of production per unit area will suffice as a basis for establishing quotas.

As long as commercial fisheries in the study area are sporadic and of low intensity, quotas can be established on the present largely intuitive but probably conservative basis. If, however, there are requests from commercial fishermen for dramatically increased catches, the establishment of safe quotas will be a priority for fishery managers. This will require for at least each major stock, some knowledge of:

1. Stock identification;
2. Stock composition (length and age distribution);
3. Stock enumeration (size of each stock);
4. The season distribution of stocks including spawning areas and migration patterns.

With this information, provisional quotas can be established, by season, area, and year, which can be adjusted when monitoring of stocks indicates that some change is required.

Monitoring of stocks

In order to determine the effects of commercial fisheries on major stocks, a baseline must be established against which to measure future changes. At a minimum, the baseline should include:

1. Some index of abundance, possible catch per unit effort using standard gear in an area where the stock is relatively unmixed, possibly in the vicinity of its spawning grounds;
2. Data describing length and age frequencies among mature fish in the population and catch curves for commercial gear.

Radical changes in any of these characteristics (i.e., a reduction in catch per unit effort or in the length and age of the stock) might be a signal that the fishery is having some serious adverse effects on the fish stock(s).

Marine species

It seems unlikely that any commercial fishery for marine species will develop in the near future. With one possible exception, none of the common, potentially exploitable species (i.e., Pacific herring, capelin, boreal smelt, Arctic and starry flounder) is sufficiently valuable to warrant the costs of fishing, processing and transport. All these species, or similar ones, are much more easily available in southern waters along either the Atlantic or Pacific coasts. A possible exception might be a commercial fishery for herring roe. Roe, a delicacy in Japan, has in recent years commanded very high prices (to $5000 per ton of unprocessed fish) though these have declined considerably this year (to about $1000 per ton). Such high value per unit weight is advantageous in a remote fishery because the cost of transportation represents a relatively smaller proportion of the market value of the product.

A roe fishery would pose serious management problems, in consideration of the following two points:

1. Almost nothing is known of life history or abundance of herring in the study area and quotas would have to be established without any real basis;
2. Fisheries of this kind, which concentrate on females and their mature sex products, taken on the spawning grounds, may be more damaging to populations than less selective fisheries which include both sexes and immature as well as mature fish. This might be a serious problem in the study area where the Pacific herring is on the periphery of its range and possibly more sensitive to overexploitation than elsewhere.

If a herring roe fishery is seriously comtemplated, a great deal more will have to be known about the biology of the species in the study area. If meaningful quotas are not established, a few good years of fishing may be followed by a crash.

Freshwater Species

There seems little opportunity in the study area for commercial fisheries on strictly freshwater populations. Among the Coregoninae (whitefish, cisco and inconnu), the anadromous populations are more easily fished and probably more productive. While there is a possibility of commercial exploitation of lake charr (for example, in the Eskimo Lakes), populations of this species might be expected to be relatively unproductive at this latitude. The lake charr appears to be more sensitive than most species to the effects of overexploitation and it would probably be best to reserve populations of this species for sport fisheries.

SPORT FISHERIES

Sport fisheries in the study area are most common on lakes, including several in the Inuvik area as well as Ya-Ya Lake on Richards Island and, to a lesser extent, the Eskimo Lakes. In addition, there are stream fisheries for Arctic charr along both the eastern and western margins of the study area. Sport fisheries can be expected to increase as development proceeds in the study area. Company sponsored, air-supported expeditions to remote locations are occurring within the study area (helicopter trips to Arctic charr spawning and overwintering areas, for example) and may become more common.

Almost nothing is known of the details of sport fisheries in the study area--locations, efforts, catches--and of the effects that such fisheries might have had on populations of fish. Eventually, as sport fishing pressure increases, it will be necessary to assess the effects of sport fisheries and to regulate them accordingly. Populations of two species in particular, the lake charr and Arctic charr, should be closely watched to determine whether populations in the more popular fishing locations are being adversely affected.

DOMESTIC FISHERIES

It is the general policy of both the Federal and Territorial governments that domestic fisheries should take precedence over other uses. At this time, domestic fisheries account for by far the largest proportion of fish taken in the study area. However, here as elsewhere in the NWT, domestic fisheries are essentially unregulated and data describing domestic fisheries catches are inadequate to support any level of sophisticated management.

Domestic fisheries could conceivably increase substantially in future as the native population continues to grow, particularly if increasing fuel prices cause an abondonment of snow machines in favour of the traditional mode of transportation, the dog team. Dog food is probably the largest single use for fish taken in domestic catches. While there have been studies of domestic fisheries in the study area in the past, most of them have viewed fisheries from a socio-economic viewpoint. What are required now are studies which detail domestic fisheries in a manner more readily utilizable by fishery managers including descriptions of gear, locations, seasons, catch per unit effort, and the characteristics of the catch (species, sex, maturity, as well as age, length, and weight data). This information is required, not just as a basis for future management of domestic fisheries, but also for regulating competing uses of fisheries resources in commercial and sports fisheries. It would be difficult, for example, to establish any meaningful quota for an intensive commercial fishery in the study area without some detailed information about how domestic and/or sport fisheries might be exploiting the same stocks.

RECOMMENDATIONS FOR FUTURE USE

DOMESTIC FISHERY EVALUATIONS

At present, domestic fisheries take by far the largest proportion (averaging about 80%) of fish catches in the study area and have the major impact on fish populations. While domestic fisheries are largely unregulated at present, such a *laissez faire* approach may not be possible in future, if the well being of fish populations is to be maintained. The first priority of any management-related investigations in the study area should be studies of domestic fisheries, especially since they represent an estimated 78 83% of the total harvest. Despite this, there have been no detailed studies of domestic fisheries from the viewpoint of the fishery manager. The manager needs to know what species are taken, in what quantities, and at what stage in their life history. In addition, he should know what effects the domestic harvest has had on specific stocks of fish. At present, there is no reliable information concerning any of the foregoing.

These studies will require the close cooperation of native groups and might best be arranged through local hunters and trappers associations.

COMMERCIAL FISHING

Any commercial fishing operations in the study area should be studied in detail--in part as a basis for regulating that fishery and, in part, as a basis for regulating any future fisheries that develop in the area. There is very little existing information on which to draw as a basis for managing fisheries such as those which are likely to develop in the Mackenzie Delta and vicinity. Very little biological information is available even from past commercial fisheries in the Delta, for example, that which operated at Holmes Creek.

It would be useful to have some of the following information:

- descriptions of gear and fishing methods
- catch per unit effort by species
- catch curves by species
- values for key life history parameters for each species
- identification and characteristics of culled fish.

STOCK DIFFERENTIATION

Stock differentiation should be a major priority of management investigations in the study area. The major problems in this regard are with those anadromous species, principally coregonines which spawn within the Delta and in some of its major tributaries, especially the Peel and Arctic Red rivers. The objectives of these studies should be, for major stocks:

1. To locate their spawning areas,
2. To describe their migration patterns,
3. To describe key life history parameters (growth rates, age structure, length frequency, etc.).
4. To establish an index of abundance such as catch per unit effort using some standard fishing technique.

This information can be used, in future, to establish when, where, and how these stocks should be fished and as a basis for assessing the impact of fisheries on individual stocks.

Studies of this kind will require a major tagging effort involving both conventional and radio tags. The latter are particularly useful in following the latter stages of migrations in large turbid streams, as fish approach their spawning grounds. One of the problems in such studies is the delicacy of some of the species which should be investigated, particularly the least and Arctic ciscoes. Methods must be devised to capture these species alive and in good condition (pound nets or floating traps are possibilities) as well as for handling and tagging them.

MARINE FISHERIES ASSESSMENT

Very little is known of the distribution, abundance, and life histories of the marine fishes in the study area. Surveys should be undertaken along the Beaufort Sea coast within the study area to assess populations of these species. The surveys could serve two purposes--as a basis for determining the fisheries potential of the area and as a basis for monitoring the impact of development on these species.

The studies will require a boat of sufficient size to handle the marine sampling gear such as midwater and bottom trawls and a purse seine.

SPORT FISHERIES

Sport fisheries are likely to have localized adverse effects on fish populations. Populations within the study area, subject to intensive sport fisheries, should be assessed in terms of abundance and values for key life history parameters (growth rates, age structure, length frequency, etc.) and monitored at intervals so that, if adverse effects are identified, the fishery can be regulated to protect the population. One regulation the authors would like to see is a ban on helicopter-support sport fisheries at Arctic charr "fish-holes". While some work of this kind is already being done, much more may be required if development results in a significant increase in the numbers of people in the study area. Of particular concern are populations of lake charr, a species which seems to be especially sensitive to angling pressure and very slow to recover from the effects of overfishing. Stream resident Arctic charr are another source of concern because of their tendency to concentrate in limited areas (fish-holes) during the fall and winter where they are very vulnerable to both sport and domestic fisheries.

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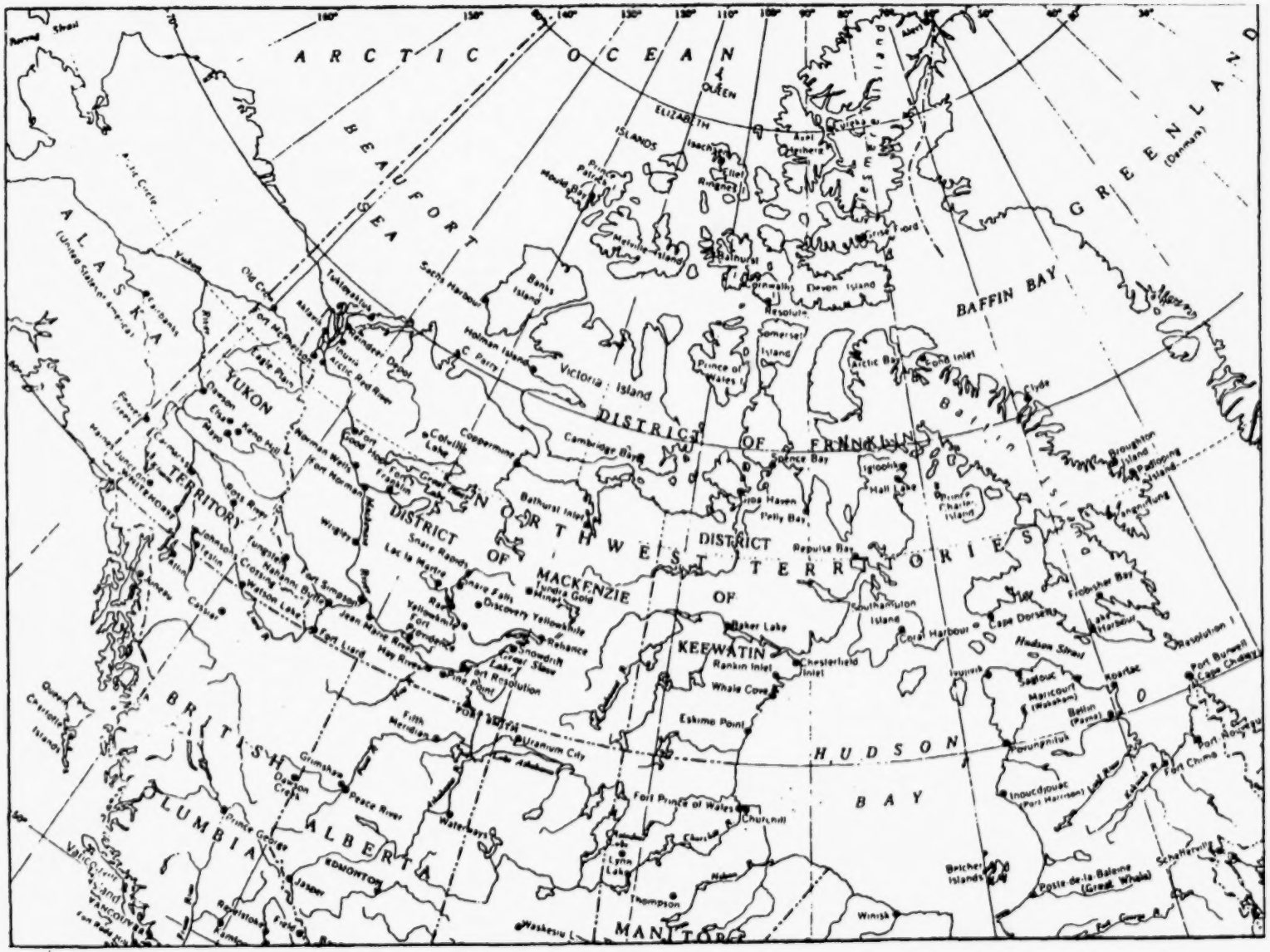

Fig. 1. Communities within the Northwest Territories.

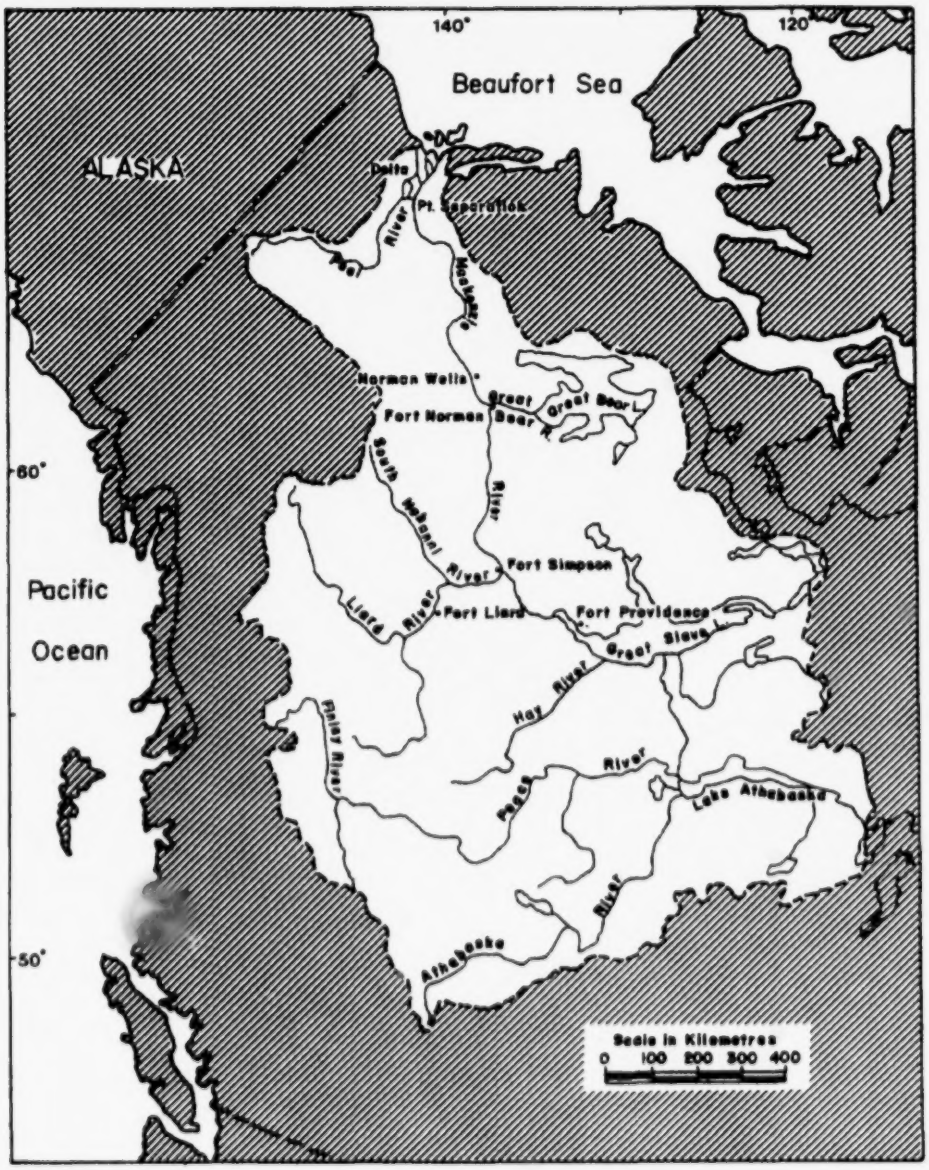

Fig. 2. The Mackenzie River drainage basin.

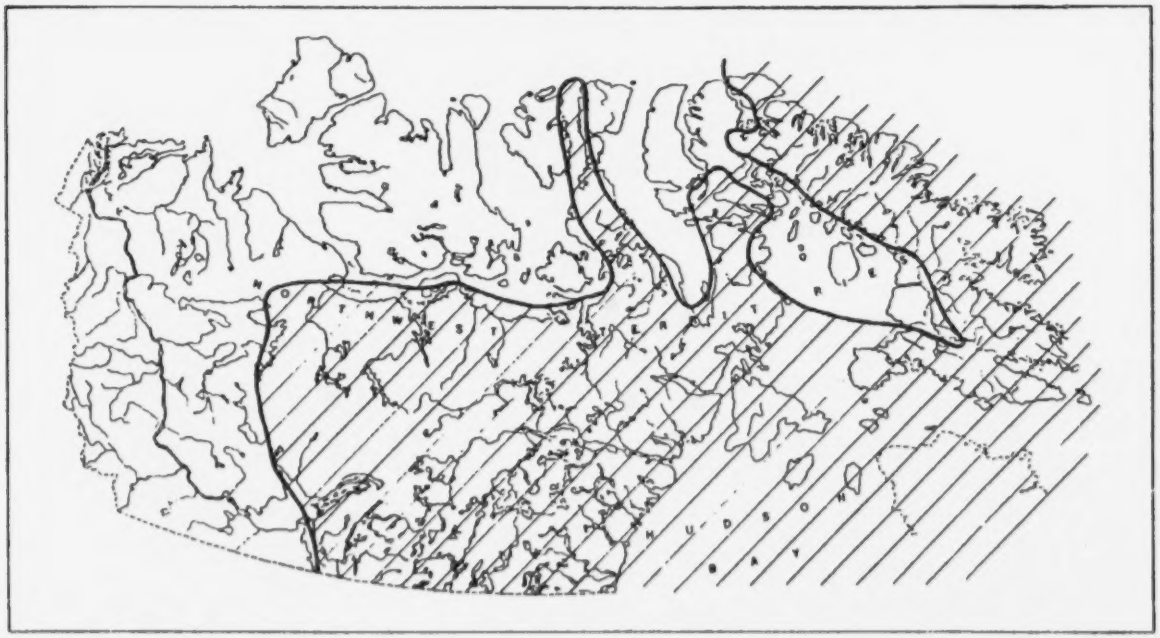

Fig. 3. Location of Canadian Shield (cross-hatched) and Borderlands (unhatched) in Northwest Territories. Shield also includes the east end of Devon Island and southeast corner of Ellesmere Island (not shown)(after Bostock 1968, McCart and Den Beste 1979).

Fig. 4. The Mackenzie River Delta.

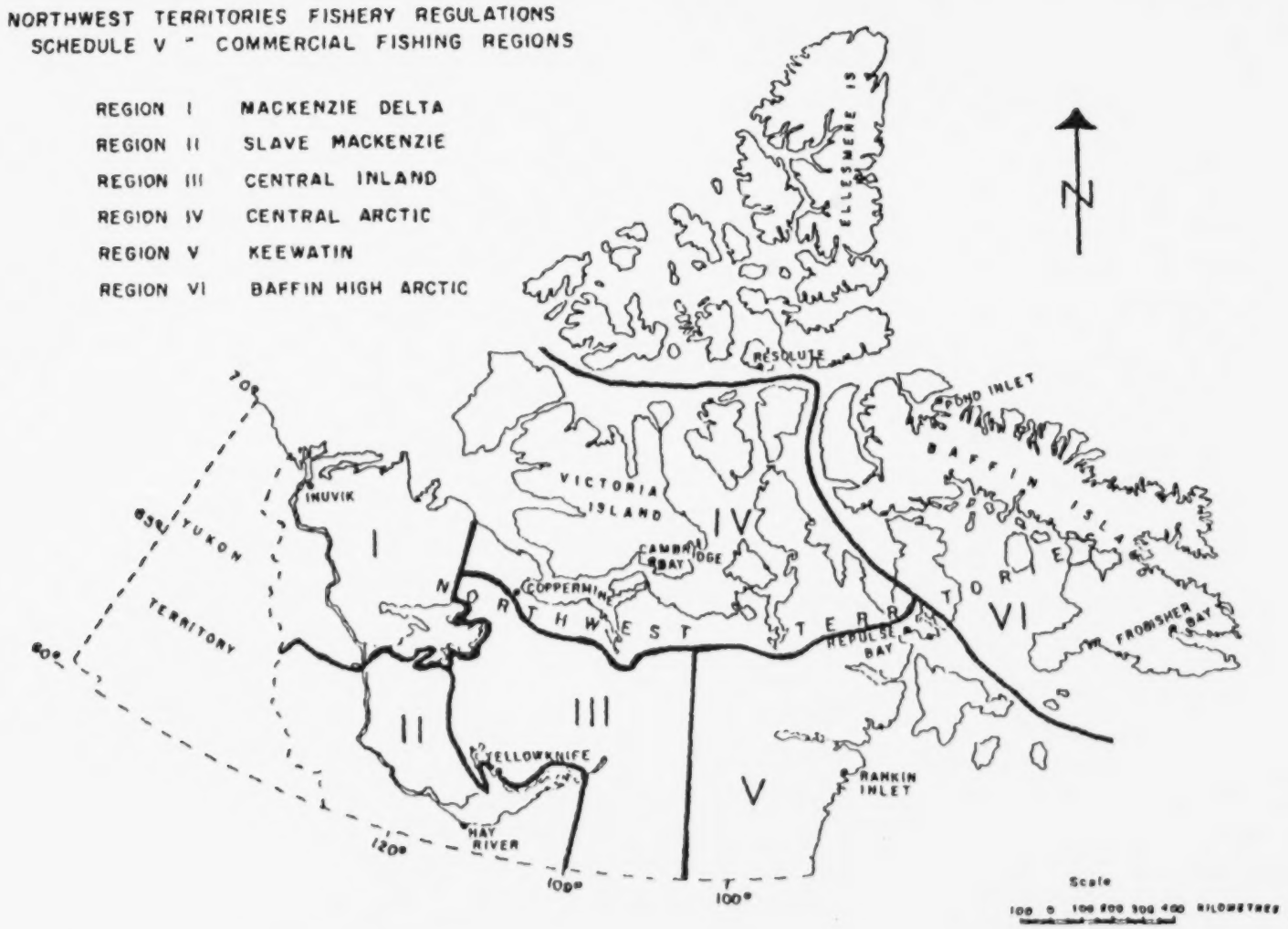

Fig. 5. Proposed commercial fishing regions of the Northwest Territories (R. Moshenko personal communication).

Fig. 6. Western region fisheries and area of operation of the Freshwater Fish Marketing Corporation (after Cauvin 1979).

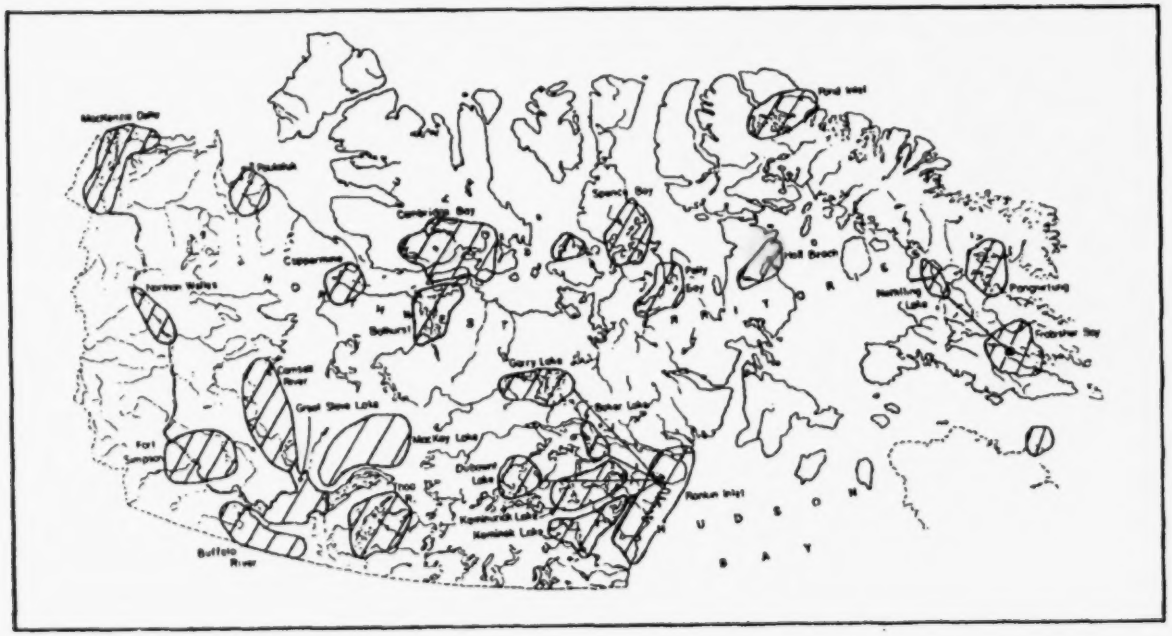

Fig. 7. Principal commercial fishery areas in the Northwest Territories (after McCart and Den Beste 1979).

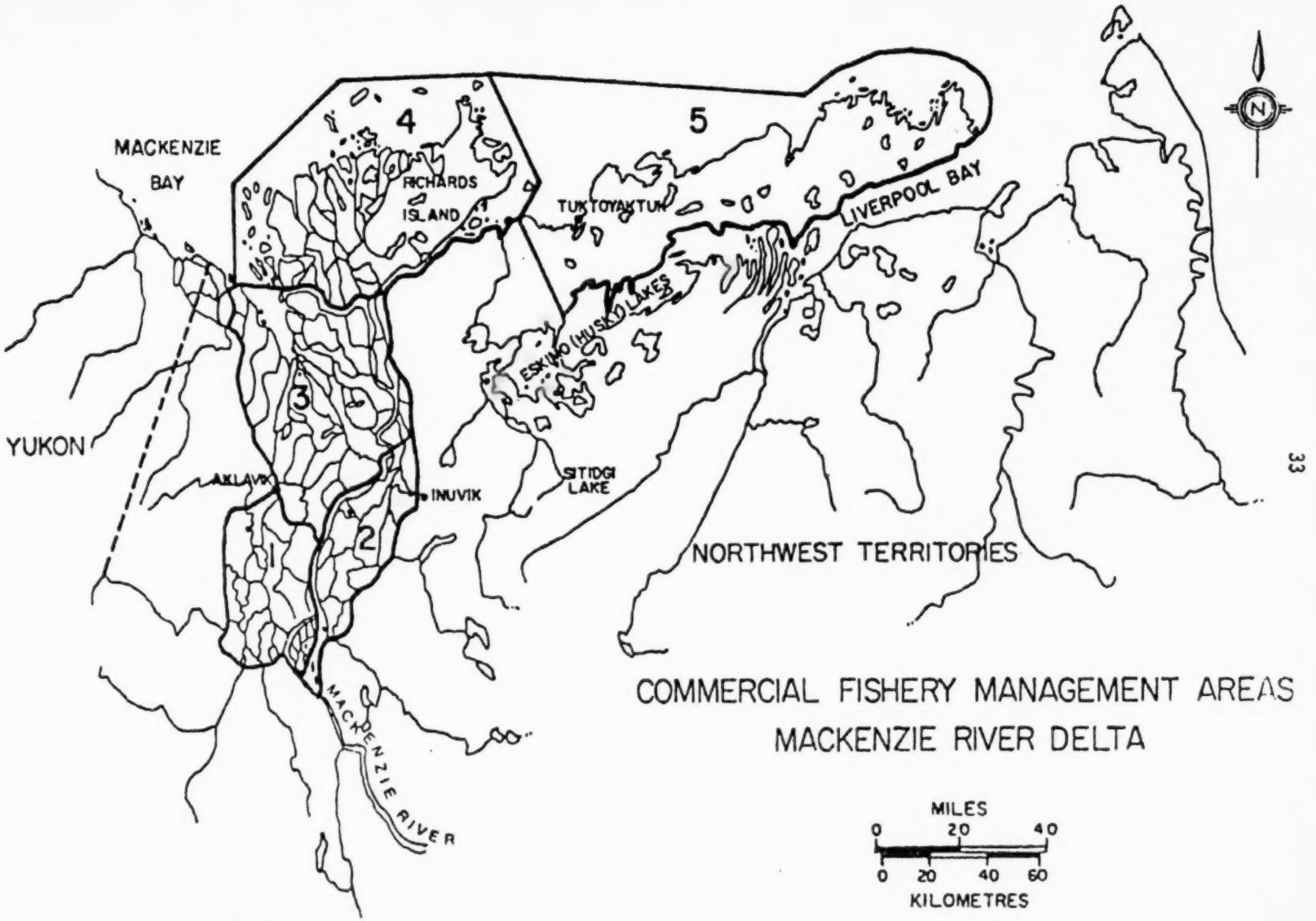

Fig. 8. Commercial fishery management areas of the Mackenzie River Delta.

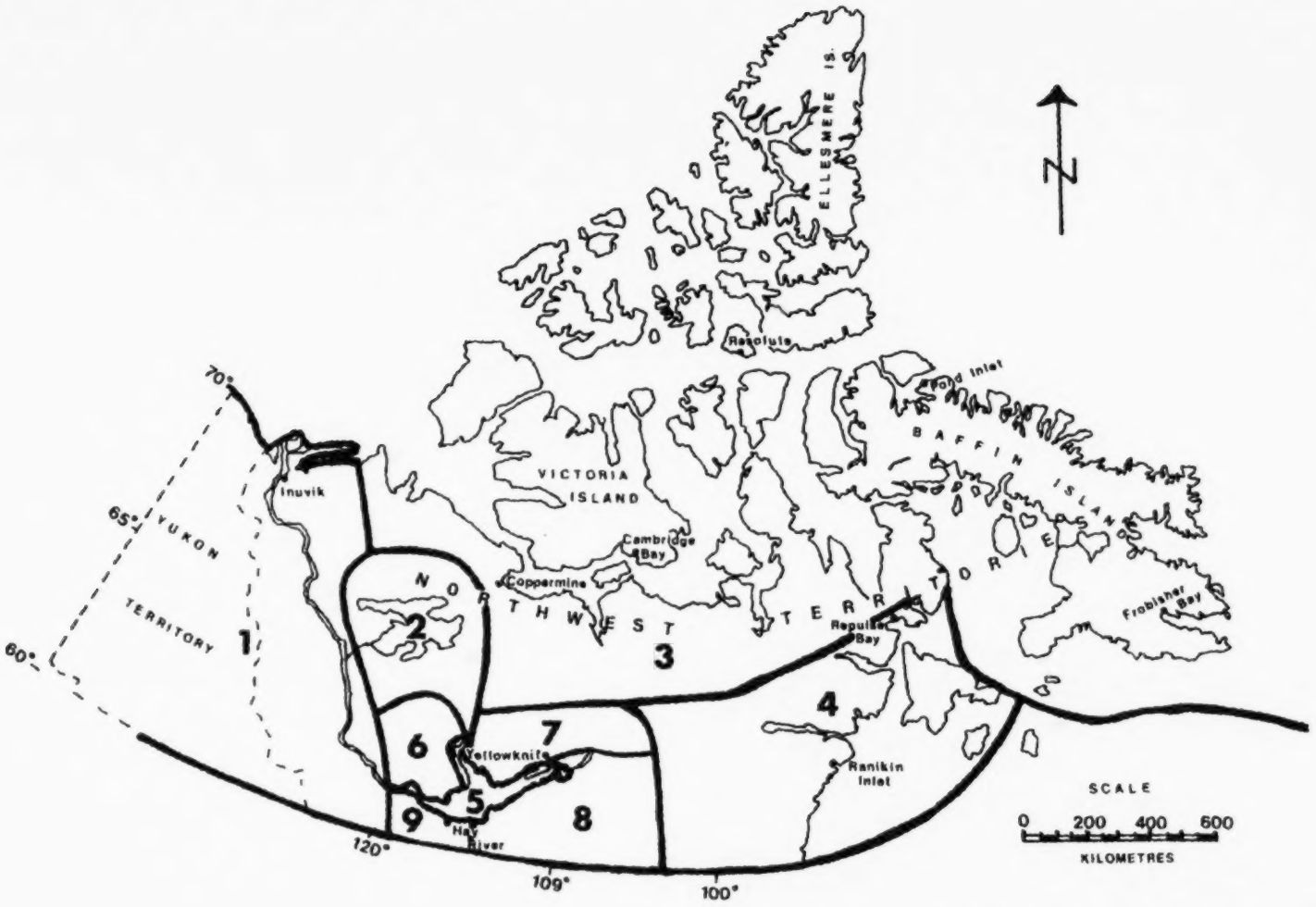

Fig. 9. Areas defined for recreational fishing survey (after D. Topolniski MS. in preparation).

Table 1. Utilization of the coastal waters by fish species commonly taken along the Mackenzie Delta (after Slaney and Co. 1976).

Species Classification	Approximate Spawning Period A M J J A S O N D J F M	Location	Nursery Areas	Feeding Areas	Wintering Areas
ANADROMOUS SPECIES					
Arctic cisco	- - -	Tributaries of the Mackenzie River including the Arctic Red, Peel, and Great Bear Rivers are suspected spawning areas (Stein et al. 1973).	Embayments, lagoons, and shallow nearshore waters along the coastline of the outer Mackenzie Delta and Barrier Islands.	Nearshore reaches of the outer Mackenzie Delta, and along the Alaska-Yukon Beaufort Sea coastline (Craig and Mann 1974).	Arctic cisco are suspected to winter in the deep brackish water areas along the outer Mackenzie Delta. Wintering fish have been collected in Mallik Bay (Percy 1975) and along the northern Yukon coastline at Shingle Pt.(Kendal et al. 1974).
Boreal smelt	- -	The Arctic Red River is a suspected spawning area (Stein et al. 1973).	Shallow nearshore and inshore coastal waters along the Mackenzie Delta and Beaufort Sea coastline.	Widespread throughout the brackish and freshwater regions of the outer Mackenzie Delta, and Beaufort Sea coastline.	Deep water regions beyond the Barrier Islands, Kugmallit Bay and waters along the Beaufort Sea coastline.
Least cisco	- -	Spawning may take place in some Delta lakes (Mann 1975), Peel Channel, Husky Channel, Red River, and in the Mackenzie River near Arctic Red River (Stein et al. 1973).	Lower Delta streams and lakes and along the shallow nearshore coastal waters of the outer Mackenzie Delta.	Shallow nearshore coastal waters of the outer Mackenzie Delta including the Barrier Islands and freshwater lakes and streams in the lower Delta.	Wintering least cisco have been taken in Delta lakes and channels (Mann 1975, Jessop and Lilley 1975), Mallik Bay and Kugmallit Bay (Percy 1975).
MARINE SPECIES					
Arctic cod	- - -	Unknown,likely the offshore marine waters of the Beaufort Sea.	Inshore waters of Kugmallit Bay and the Beaufort Sea.	Unknown, likely the deeper offshore marine waters of the Beaufort Sea.	Unknown, likely the deeper offshore marine waters of the Beaufort Sea.
Arctic flounder	- - -	Unknown, spawning likely takes place in the inshore brackish and offshore marine waters of Mackenzie Bay.	Brackish coastal waters of the Outer Mackenzie Delta.	Brackish waters along the northeast coastline of Richards Island, Mallik Bay (Percy 1975) and the Barrier Islands.	Likely throughout the inshore and offshore marine waters of East Mackenzie Bay, and Kugmallit Bay, and the deepwater embayments of Richards Island. Arctic flounder have been taken under ice in Mallik Bay (Percy 1975).

(Continued)

Table 1. Continued

Species Classification	Approximate Spawning Period A M J J A S O N D J F M	Location	Nursery Areas	Feeding Areas	Wintering Areas
Fourhorn sculpin	- - -	Likely widespread over winter range; ripe and spent fish were collected under ice cover in Mallik Bay (Percy 1975).	Nearshore brackish water of the outer Mackenzie Delta, Barrier Islands, and along the Beaufort Sea coastline	Widespread throughout the brackish water regions of the outer Mackenzie Delta, and Beaufort Sea coastline.	Deep water embayments and inshore marine waters along the outer Mackenzie Delta and Beaufort Sea coastline. Wintering sculpins were taken in Mallik and Mason Bays (Percy 1975), and at Shingle Pt. (Kendal et al. 1974).
Pacific herring	- -	Unknown. Along Tuktoyaktuk Peninsula Pacific herring are reported to spawn in spring in shallow brackish water bays and at river mouths (Riske 1960).	Young-of-the-year have not been taken in the inshore and nearshore coastal waters of the Mackenzie Delta, but are reported to have been found along the Tuktoyaktuk Penninsula (Hunter 1975).	Brackish water bays and lagoons along the northeast coastline of Richards Island. Principal feeding area is likely the offshore marine waters of the Beaufort Sea.	Pacific herring are suspected to congregate during winter in the vicinity of spawning grounds nearshore (Riske 1960). Herring have been taken under ice in Mallik Bay (Percy 1975).
Saffron cod	- - -	Unknown, likely the offshore marine waters of the Beaufort Sea.	Unknown, young-of-the-year have not been collected in the inshore or nearshore coastal reaches of the Mackenzie Delta.	Limited utilization of nearshore brackish waters along the Barrier Islands and Richards Island.	The offshore marine waters of the Beaufort Sea likely serve as wintering areas.
Broad whitefish	- -	Broad whitefish are suspected to spawn within the vicinity of the mouth of the Arctic Red River and near Horseshoe Bend on the Main Channel (Jessop et al. 1974).	Whitefish (unidentified to species) young-of-the-year utilize delta lakes (Percy 1975), lagoons and shallow nearshore coastal waters of the Mackenzie Delta and Barrier Islands as nursery areas.	Lakes and channels of the outer Mackenzie Delta (Percy 1975). In the coastal areas adult broad whitefish remain within close proximity to river and channel mouths.	Freshwater lakes and channels in the lower and upper Mackenzie Delta (Mann 1975, Jessop and Lilley 1975).
Humpback whitefish	- -	Spawning is suspected to take place within the vicinity of the Arctic Red River (Stein et al. 1973).	Same as above	Lakes and channels of the outer Mackenzie Delta (Percy 1975). Like broad whitefish, adults of this species remain within close proximity to river and channel mouths.	Lakes and channels in the lower Mackenzie Delta (Mann 1975).

(Continued)

Table 1. Concluded

Species Classification	Approximate Spawning Period A M J J A S O N D J F M	Location	Nursery Areas	Feeding Areas	Wintering Areas
Inconnu	- -	Spawning is suspected to occur in tributaries of the Peel and Arctic Red River (Stein et al. 1973).	The coastal waters of the outer Mackenzie Delta do not serve as nursery area for this species.	Coastal shoreline within close proximity to river and channel mouths. Principally lake and channels of the lower Delta and Mallik and Mason Bays (Percy 1975).	Inconnu have been taken in lakes and channels (Mann 1975) in the lower Mackenzie Delta, and at Mallik Bay under ice (Percy 1975). 3/

Table 2. Fishes of the Mackenzie Delta and Beaufort Sea.

Fish (scientific name)	Common Name	Mackenzie Delta	Beaufort Sea
Petromyzontidae	lamprey		
Lampetra japonica	Arctic lamprey	X	X
Hiodontidae	mooneyes		
Hiodon alosoides	goldeye	X	
Clupeidae	herring		
Clupea harengus	Pacific herring	X	X
Esocidae	pike		
Esox lucius	northern pike	X	
Salmonidae	whitefish, grayling, salmon and charr		
Coregoninae	whitefishes		
Coregonus artedi	lake cisco	X	
C. autumnalis	Arctic cisco	X	X
C. laurettae	Bering cisco	(unconfirmed)	
C. sardinella	least cisco	X	X
C. clupeaformis	lake (humpback) whitefish	X	X
C. nasus	broad whitefish	X	X
Prosopium cylindraceum	round whitefish	X	X
Stenodus leucichthys	inconnu	X	X
Thymallinae	grayling		
Thymallus arcticus	Arctic grayling	X	X
Salmoninae	salmon, charr		
Oncorhynchus gorbuscha	pink salmon		X
O. keta	chum salmon	X	X
O. kisutch	coho salmon	(unconfirmed)	
Salvelinus alpinus	Arctic charr	X	X
S. malma	Dolly Varden	(unconfirmed)	
S. namaycush	lake trout or charr	X	X
Osmeridae	smelts		
Hypomesus olidus	pond smelt	X	X
Mallotus villosus	capelin		X
Osmerus mordax	rainbow smelt	X	X
Cyprinidae	minnows		
Couesius plumbeus	lake chub	X	
Platygobio gracilis	flathead chub	X	
Notropis atherinoides	emerald shiner	X	
N. hudsonius	spottail shiner	X	
Chrosomus eos	northern redbelly dace	X	
C. neogaeus	finescale dace	X	
Rhinichthys cataractae	longnose dace	X	
Catostomidae	suckers		
Catostomus catostomus	longnose sucker	X	X
C. commersoni	white sucker	(unconfirmed)	
Percopsidae	trout - perches		
Percopsis omiscomaycus	trout - perch	X	
Gadidae	cod fishes		
Arctogadus glacialis	polar cod		X
Boreogadus saida	Arctic cod		X
Eleginus gracilis	saffron cod	X	X
Gadus ogac	ogac		X
Lota lota	burbot	X	X
Zoarcidae	eelpouts		
Lycodes jugorius	shulupaoluk		X
L. pallidus	pale eelpout		X
L. reticulatus	Arctic eelpout		(unconfirmed)
L. vossi	Threespot eelpout		(unconfirmed)
L. turneri	ribboned eelpout		(unconfirmed)
Gasterosteidae	sticklebacks		
Culaea inconstans	brook sticklebacks	X	
Pungitius pungitius	ninespine stickleback	X	X
Cottidae	sculpins		
Artedidellus scaber	rough hookear		X
Cottus cognatus	slimy sculpin	X	

(Continued)

Table 2. Concluded.

Fish (scientific name)	Common Name	Mackenzie Delta	Beaufort Sea
C. ricei	spoonhead sculpin	X	X
Gymnocanthus tricuspis	Arctic staghorn sculpin		X
Icelus bicornis	twohorn sculpin		X
I. spatula	spatulate sculpin		X
Myoxocephalus quadricornis	fourhorn sculpin	X	X
M. scorpioides	Arctic sculpin		X
Triglops pingeli	ribbed sculpin		X
Agonidae	poachers		
Aspidophoroides olriki	Arctic alligatorfish		X
Cyclopteridae	snail fishes		
Liparis cyclostigma	polka-dot snailfish		X
L. herschelinus	bartail seasnail		X
L. koefoedi	gelatinous seasnail		X
Percidae	perches		
Stizostedion vitreum vitreum	walleye	X	
Stichaeidae	pricklebacks		
Acantholumpenus mackayi	blackline prickleback		X
Lumpenus fabricii	slender eelblenny		X
Ammodytidae	sand lances		
Ammodytes hexapterus	Pacific sand lance		X
Pleuronictidae	righteye flounders		
Liopsetta glacialis	Arctic flounder		X
Platichthys stellatus	starry flounder		X

Table 3. List of freshwater fish species important in domestic, commercial and sport fisheries in the Northwest Territories (after Fisheries and Environment Canada 1977).

Family	Species Name		Fisheries	
	Common	Scientific	Domestic/ Commercial	Sport
Salmonidae	Rainbow trout	*Salmo gairdneri*		+
	Arctic charr	*Salvelinus alpinus*	+	+
	Dolly Varden	*Salvelinus malma*		+
	Brook trout	*Salvelinus fontinalis*		+
	Lake trout	*Salvelinus namaycush*	+	+
	Lake cisco	*Coregonus artedii*	+	+
	Arctic cisco	*Coregonus autumnalis*	+	+
	Least cisco	*Coregonus sardinella*	+	+
	Lake (humpback) whitefish	*Coregonus clupeaformis*	+	+
	Broad whitefish	*Coregonus nasus*	+	+
	Round whitefish	*Prosopium cylindraceum*	+	
	Inconnu	*Stenodus leucichthys*	+	+
	Arctic grayling	*Thymallus arcticus*		+
Hiodontidae	Goldeye	*Hiodon alosoides*		+
Esocidae	Northern pike	*Esox lucius*	+	+
Gadidae	Burbot	*Lota lota*	+	
Percidae	Walleye	*Stizostedion vitreum*	+	+
			12	15

Table 4. Information sources for fish harvest data used in this report.

Information	Table	Source
Commercial Fish Harvests (Exported)		
FFMC[b] Regional Fisheries	7	B. Wong (DFO[a], Yellowknife)
Northwest Territories	8	B. Wong (DFO , Yellowknife)
Mackenzie River Delta	9, 12, 20	B. Wong & D. Moshenko (DFO, Yellowknife)
Central Arctic	10	B. Wong (DFO, Yellowknife)
Cambridge Bay, Gjoa Haven & Pelly Bay	6	Kristofferson & Carder (1980)
	11	D. Topolniski (DFO, Winnipeg)
Commercial Fish Harvests (Local Sales)		
Mackenzie River Delta & environs	13, 14, 15, 20	R. Barnes (DFO, Inuvik)
Domestic Fish Harvests		
Mackenzie River Delta & environs	17, 18, 19, 20	R. Barnes (DFO, Inuvik)
	16	Wolforth (1966) Sinclair et al (1967) Hunt (1972, 1973) DIAND/MPS (1973) Jessop et al (1974) Usher (1975) Olesh (1979)
Sport Fish Harvests		
Northwest Territories	23	D. Topolniski (DFO, Winnipeg)
Mackenzie Delta	25	Telephone Interviews

a - Department of Fisheries and Oceans.

b - Freshwater Fish Marketing Corporation.

Table 5. Chronological development of commercial fishing attempts within the Mackenzie Delta and Beaufort Sea. Data obtained from Barlishen and Webber (1973), McLeod (1973), Olesh (1979), manuscripts and memos in files of R. T. Barnes, Fisheries Officer, Inuvik. 1 lb. = 0.45 kg.

Year	Comments
Prior to 1960	Fishing in the Delta area was conducted by Inuit and Indian inhabitants. Fishermen were frequently hired by church missions and the Royal Canadian Mounted Police (R.C.M.P.) During the 1950's, a local trader at Fort McPherson attempted a winter commercial fishery, but the venture failed due to lack of interest and markets.
1960	The Department of Northern Affairs and National Resources (DNANR) established fisheries at East Whitefish Station (Kittigazuit) and at the mouth of the Peel River. Because of unreliable freezing equipment, the Whitefish Station harvested only 12 000 lb; the fish were marketed in Inuvik. Similar technical problems occurred at the Peel River fishery. Here, 3 000 lb of fish were caught and sold to the Department of Indian Affairs for relief issued.
1960	DNANR initiated a fishery at Shingle Point on the Yukon coast. There were 18 000 lb of unspecified fish harvested.
1961	During the final year of the Shingle Point fishery, 12 000 lb of fish were harvested. The fishing program was discontinued.
1961	DNANR established a fishery at Aklavik. Obsolete and malfunctioning equipment hindered production. The Peel River and West Channel yielded 26 739 lb of fish. Broad whitefish *(Coregonus nasus)* dominated the catch, but humpbacks (*C. clupeaformis)* and inconnu *(Stenodus leucichthys)* were also taken. Using gillnets (150 ft long X 6 ft deep or 83.67 m^2 with a mesh size of 4.5 inches (11.4 cm), 52.5 lb of fish were harvested per net day.
1962	Freezer and storage space was still lacking at Aklavik. Some fish, however, were caught and dried for local sales in Aklavik and Inuvik.
1963	An experimental Pacific herring *(Clupea harengus)* fishery was initiated near Baillie Island. Although sufficient herring was harvested for market assessment (18 000 lb), numerous difficulties were encountered: clogged gillnets, lack of access to regular supplies, hazardous fishing conditions, transportation of freshwater. Due to high production and transportation costs, Beaufort Sea herring was not competitive with the Scandanavian market.
1963	The Department of Indian Affairs and Northern Development (DIAND) established a small fishery at Holmes Creek, 105 km north of Inuvik. Several mechanical difficulties were encountered using a barge with freezer mounted facilities. About 20 000 lb of whitefish and some inconnu were harvested with a catch effort of 69.7 lb per net day (surface area of each net: 83.67 m^2). Since most individuals harvested fish for their own needs, there was little local demand for the commercially harvested product. Fish were purchased by hostels and the Inuvik Rehabilitation Centre.
1964	Test fishing was conducted in Liverpool Bay with unsatisfactory results.
1964	A housing co-operative at Inuvik expressed an interest in establishing a fishery for local sales, but no fish handling or storage facilities were available. Lack of funds prevented further action.
1964	DIAND continued a commerical fishery at Holmes Creek. In all, 77 354 lb of fish were harvested (123 lb per net day) including 42 450 lb of marketed whitefish, 34 904 lb of culled fish and 11 301 lb of rough fish (sucker, cisco and pike). Again, mechanical difficulties were encountered with a bargemounted fish production plant which had been shipped to Holmes Creek from Kendall Island.
1965	A local trader at Fort McPherson was denied a commercial license because of priority given to domestic fishermen.
1965	Local fishermen attempted to continue a commercial fishery selling their catch to merchants in Inuvik. Further interest was expressed in establishing a co-operative fishery; the government of the Northwest Territories (GNWT) discouraged the plan.

(Continued)

Table 5. Continued.

Year	Comments
1965	A private firm, Menzies Fish Company Ltd. of Edmonton, began a commercial fishery in the area. Local fishermen caught whitefish in the Delta between Inuvik and Aklavik. Arctic charr (*Salvelinus alpinus*) was harvested at Pauline Cove on Herschel Island and at Ptarmigan Bay along the Yukon coast. The GNWT rented gear to fishermen who sold their catch to Menzies. The venture was unsuccessful owing to loss of equipment (a boat) and transportation costs. There were 19 930 lbs. of whitefish harvested from the Delta. Arctic char catches from Pauline Cove and Ptarmigan Bay totalled 550 and 15 534 lb, respectively.
1965	A market survey was conducted to determine prospects for local sales from a commercial fishery. Although the Royal Canadian Navy consumed large fish supplies, they were not permitted to purchase fish locally. The two hostels preferred to buy fish directly from fishermen. Since the middleman was eliminated and whole, rather than filleted fish were available, costs were cheaper. Inuvik merchants and the hospital, however, were willing to purchase fish from a local commercial fishery.
1966	Menzies Fish Co. Ltd. made a second unsuccessful attempt at a commercial fishery in the Delta (6 998 lb of all species were harvested). A total of 800 lb of Arctic charr was taken from Ptarmigan Bay. Mechanical and technical problems, spoiled fish, transportation costs, and discontented fishermen all contributed to the collapse of the industry.
1966	A test fishery was proposed for the Delta to determine production, shipping and marketing procedures and costs. This program, however, was postponed until necessary funds became available.
1967-1971	Various commercial fisheries were proposed for the Delta, but none were implemented.
1968	An Arctic charr fishery was initiated on the Hornaday River, near Paulatuk. Initially a 5 000 lb quota was assigned to the area. The fishery has continued until the present with the catch and quota being increased to 15 000 lb.
1972	The GNWT, again, established a commercial fishery at Holmes Creek. Cooler and freezing facilities proved to be inadequate. Inuvik provided the only available local market. Export to southern markets was too expensive. The following products were harvested: 3 000 to 6 000 lb frozen whole whitefish, 3 000 to 6 000 dressed whitefish, 20 000 to 27 000 lb frozen whitefish fillets.
1973	The Holmes Creek fishery obtained their 50 000 lb quota within six weeks well before the autumn whitefish run. The catch was sold locally in Inuvik.
1974	The Holmes Creek fishery attained only two thirds of their quota. Despite a longer fishing season only 32 847 lb of fish were harvested. Thirty per cent of the catch was sold locally in Inuvik; the remainder was sold to the Freshwater Fish Marketing Corporation (FFMC) in Winnipeg.
1975	The Holmes Creek fishery plant was relocated to Inuvik. The 50 000 lb quota (mainly broad whitefish) was attained by August, but a portion of the catch did not pass fish inspection regulations. The fishery was closed because it proved too uneconomical to maintain.
1976-1979	Although many domestic fishermen purchased commercial fishery licenses so that they could sell a portion of their catch locally, no commercial fisheries were established.
1979	The Inuvialuit Development Corporation (IDC), an organization supported by the Committee for Original Peoples Entitlement (COPE), expressed a strong interest in establishing a commercial fishery for whitefish in the Delta region and for Pacific herring in the Beaufort Sea. A Western Arctic Resource Evaluation study (Olesh 1979) was prepared. IDC requested Foodwest Resource Consultants to prepare a proposal to conduct a feasibility study for a commercial fishery. IDC's Country Foods Co-operative would be used as a local outlet for the sale of fish.
1980	IDC applied to the GNWT's Department of Economic Development and Tourism for a grant ($195 000) to conduct a test fishery and feasibility study in the Mackenzie Delta and coastal regions. A wildlife officer, S. Ransom, of the Department of Renewable Resources (GNWT) transported a fish plant from the Tuktoyaktuk to Inuvik to facilitate the anticipated summer fish studies. Since then, IDC has been unsuccessful in obtaining a grant to continue with the project and, to date, no further action has been taken.

Table 6. Production of anadromous Arctic charr by system, throughout the history of the Cambridge Bay commercial fishery (1960-78), quotas in brackets (after Kristofferson and Carder 1980).

System	Annual Production (pounds round weight)									
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Ekalluk R.	35 000 (experimental)		12 709 (40 000)	30 588 (40 000)	34 181 (40 000)	46 000 (40 000)	37 000 (40 000)	61 000 (100 000)[b]	75 609 (100 000)[b]	50 000 (100 000)[b]
Halovik R. (30 mile R.)									5 763 (100 000)[b]	57 000 (100 000)[b]
Paliryuak R. (Surrey R.)									14 250 (100 000)[b]	
Lauchlan R. (Byron Bay)				5 000 (NIL)[d]						
Ellice R.										
Perry R.										
Jayco R.										
Elu Inlet										
Dease Point (2 rivers)										
Cambridge Bay (Greiner River)	4 500 (experimental)	16 635 (23 000)								
Ferguson Lake			4 246 (40 000)[e]	569 (40 000)[e]	1 341 (40 000)[e]	1 000 (40 000)[e]				
Starvation Cove										
Padliak Inlet										

a Pound weight calculated using a dressed weight - round weight conversion factor of 1.25.

b Area quota allocated to Wellington Bay.

c Test fishery permit.

d No quota assigned.

e Combined quota primarily for lake trout with Arctic charr as incidental catch.

(Continued)

Table 6. Concluded.

System	Annual Production (pounds round weight) 1970	1971	1972	1973	1974	1975	1976	1977	1978[a]
Ekalluk R.	----------	CLOSED	---------	21 205 (40 000)	27 646 (25 000)	27 030 (25 000)	30 045 (25 000)	35 047 (25 000)	32 153 (25 000)
Halovik R. (30 mile R.)	57 768 (100 000)[b]	23 000 (100 000)[b]	14 280 (20 000)	4 229 (20 000)	----- CLOSED -----		6 129 (20 000)	10 195 (10 000)	12 641 (10 000)
Paliryuak R. (Surrey R.)	12 959 (100 000)[b]							7 173 (10 000)[c]	18 554 (15 000)[c]
Lauchlan R. (Byron Bay)	5 336 (100 000)[b]	42 000 (100 000)[b]	46 283 (40 000)	21 289 (40 000)	17 913 (25 000)	-----	CLOSED -----	3 348 (15 000)	18 818 (15 000)
Ellice R.		28 250 (50 000)	27 610 (25 000)	15 960 (25 000)	15 336 (25 000)	22 834 (25 000)	27 952 (30 000)	45 847 (30 000)	20 101 (30 000)
Perry R.								30 091 (25 000)	17 935 (25 000)
Jayco R.						18 146 (15 000)	20 805 (15 000)	16 674 (15 000)	29 573 (25 000)
Elu Inlet								5 782 (5 000)[c]	578 (5 000)[c]
Dease Point (2 rivers)			19 594 (20 000)		6 660 (50 000)		2 572 (45 000)		
Cambridge Bay (Greiner River)									
Ferguson Lake					2 870 (25 000)[e]	958 (25 000)[e]			
Starvation Cove								14 038 (NIL)[d]	
Padliak Inlet								1 949 (5 000)[c]	

a Pound weight calculated using a dressed weight - round weight conversion factor of 1.25.

b Area quota allocated to Wellington Bay.

c Test fishery permit.

d No quota assigned.

e Combined quota primarily for lake trout with Arctic charr as incidental catch.

Table 7. FFMC regional fisheries - commercial catches and landed values of principal species, 1972-79[a]. Quantities (Q) in thousand pounds round weight and landed value (V) in thousand dollars (data from B. Wong, Yellowknife).

SPECIES	1972-73		1973-74		1974-75		1975-76		1976-77		1977-78		1978-79	
	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V
Export Whitefish	8 696	1 876	7 408	1 760	7 285	1 891	8 289	2 242	8 263	2 559	8 985	2 837	9 022	4 110
Continental Whitefish	3 510	525	3 301	483	3 708	576	2 195	388	2 682	530	2 983	568	2 939	799
Smoker Whitefish	1 206	323	2 475	734	2 298	632	2 066	696	2 350	865	2 808	1 035	3 579	1 708
Cutter Whitefish	3 018	202	1 424	129	1 335	140	2 286	245	2 152	227	1 940	192	1 018	146
Pickerel	7 456	2 693	6 673	2 594	6 668	2 543	7 586	3 307	9 255	5 899	10 079	6 702	8 310	5 862
Sauger	4 032	1 224	4 146	1 362	3 920	1 242	4 217	1 582	3 613	2 230	3 333	1 423	3 082	1 209
Northern Pike	7 868	651	6 546	625	6 884	701	6 703	699	7 649	748	8 143	1 034	8 187	1 638
Lake Trout	1 272	219	1 306	259	1 183	258	1 171	237	1 579	341	1 815	517	1 216	455
Tullibee	678	46	660	74	2 325	195	1 649	141	1 018	148	1 148	177	865	259
Mullets	5 682	138	4 614	189	6 937	322	4 811	210	636	26	3 547	153	4 452	219
Perch	178	23	129	17	199	25	135	23	116	30	106	52	129	69
Arctic Charr	-	-	-	-	35	15	72	89	117	210	282	403	167	239
Inconnu	191	20	220	27	210	25	222	24	175	19	200	27	368	52
Others	948	31	1 472	101	2 032	128	1 458	116	1 215	140	1 722	139	1 621	172
All Species	44 735	7 971	40 374	8 354	45 019	8 693	42 860	9 999	40 820	13 972	47 091	15 259	44 956	16 937

[a]Fiscal Year May 1 to April 30.

Table 8. Northwest Territories - commercial catches and landed values of principal species, 1972-79[a]. Quantities (Q) in thousand pounds round weight and landed values (V) in thousand dollars (data from B. Wong, Yellowknife).

SPECIES	1972-73		1973-74		1974-75		1975-76		1976-77		1977-78		1978-79	
	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V
Export Whitefish	2 056	466	1 421	377	1 265	354	1 537	419	1 482	414	2 596	801	2 042	911
Continental Whitefish	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smoker Whitefish	427	116	977	274	973	251	186	56	593	173	255	74	331	158
Cutter Whitefish	12	3	1	-	1	-	-	-	15	5	-	-	-	-
Pickerel	159	53	100	37	81	30	103	46	70	51	65	36	34	20
Northern Pike	279	20	259	24	226	23	235	23	231	23	270	31	391	72
Lake Trout	325	71	252	68	144	40	213	55	180	49	253	85	263	104
Arctic Charr	-	-	-	-	35	15	72	89	101	186	282	403	167	239
Inconnu	191	20	220	27	210	25	222	24	175	19	200	27	368	52
Others	50	-	22	-	-	-	-	-	-	-	-	-	1	1
All Species	3 499	749	3 252	807	2 935	738	2 568	712	2 847	920	3 921	1 457	3 599	1 558

[a]Fiscal Year May 1 to April 30.

Table 9. Commercial fish harvest (lb) from region I (Mackenzie Delta and environs). The extent of region I is indicated on Figure 5. All data recorded as round weight (1 lb = 0.45 kg). Data from 1977 - 1979 obtained from B. Wong, Yellowknife; 1980 data obtained in a letter (February 13, 1981) from D. Moshenko, Chief Enforcement Officer, Yellowknife to R.T. Barnes, Fisheries Officer, Inuvik.

Location	1977	1978	1979	1980
Region I				
Mackenzie Delta and environs:				
Delta (Areas 1-5)[a]	1 150	8 500	21 466	43 152
Hornaday River	13 950			14 140
Sitidgi Lake	2 000			
Total	17 100	8 500	21 466	57 292
All NWT	3 921 000	3 599 000		
Region I/NWT (%)	0.44	0.23		

[a]Mackenzie Delta areas (1-5) are indicated in Figure 8.

Table 10. Commercial fish harvest (lb) from region IV (Central Arctic). The extent of region IV is indicated on Figure 5. All data recorded as round weight (1 lb = 0.45 kg). Data obtained from B. Wong, Yellowknife.

Location	1976	1977	1978	1979
Region IV				
Central Arctic:				
Coppermine River				1 500
Ekalluk River	30 045	30 301	28 989	30 665[a]
Ellice River	27 952	38 779	19 412	13 924[a]
Kellett River		8 087	8 086	2 057
Kitiga Lake				968
Lauchlan River (Byron Bay)				21 041[a]
Lord Lindsay Lake		7 648	4 755	
Murchison River				3 070
Perry River		25 533	18 340	3 368
Port Parry Area (Gjoa Haven)			5 000	
Surrey Lake		7 173		
Unnamed R., Albert Edward Bay, Victoria Island (69-32N,103-00W)		16 674		
Unnamed R., Dease Point (68-16N,104-58W)[b]		2 187		
Unnamed L. (#75-5) Cambridge Bay Area (69-29N,104-02W)[c]		321		
Unnamed L. (#73-13) Cambridge Bay Area (69-40N,104-05W)		361		
Unnamed L. (#73-18) Cambridge Bay Area (69-45N,104-00W)		23 056		
Unnamed L. (#73-21) Cambridge Bay Area (69-48N, 104-12W)		12 282		
Unnamed L., East Spence Bay		1 112		
Unnamed R., Collinson Peninsula (69-56N,101-25W)				2 122[a]
Total	57 997	173 514	84 582	78 715
All NWT		3 921 000	3 599 000	
Region IV/All NWT (%)		4.42	2.35	

[a] Round weight = dressed weight + 0.10 dressed weight.

[b] Lake number identified in harvest data obtained from B. Wong, Yellowknife.

[c] Location of lake number obtained in a letter (May 29, 1973) from G. R. Douglas, Director of Fisheries Operations, Fisheries and Marine Service, Central Region to Dr. T. Espie, Director, Dept. of Industry and Development, GNWT.

Table 11. Seasonal fish harvests (lb) recorded for Cambridge Bay, Gjoa Haven and Pelly Bay, 1974/75 to 1978/79. (Obtained from D. Topolniski, DFO Winnipeg based on FFMC trend data).

Year	Cambridge Bay Lake trout	Cambridge Bay A. charr	Cambridge Bay Other	Gjoa Haven A. charr	Pelly Bay A. charr
1974/75[a]					
Winter					34 876
Summer					
Total Annual					34 876
1975/76					
Winter		5 400			4 140
Summer		50 310			12 272
Total Annual		55 710			16 412
1976/77					
Winter		82 980			12 240
Summer		5 970			
Total Annual		88 950			12 240
1977/78					
Winter	4 980	47 880	7 140	1 440	4 839
Summer		122 310			11 520
Total Annual	4 980	170 190	7 140	1 440	16 359
1978/79					
Winter					
Summer		125 640			7 830
Total Annual		125 640			7 830

[a]No data available for these communities from 1970/71 to 1973/74.

Table 12. Summaries of commercial catch data (lb) from the Mackenzie Delta area, 1955 - 1980 (from B. Wong, Fisheries Biologist, Yellowknife). 1 lb = 0.45 kg.

Year	Whitefish[a]	Arctic Charr	Inconnu	Northern Pike	Others[b]	Mixed[c]	Total
1955						1 654	1 654
1956						18 699	18 699
1957	1 345		17	137		8 728	10 227
1958						28	28
1959							
1960	12 000					13 148	25 148
1961	40 049		2 129			11 000	53 178
1962	19 324		3 551	5 227	9 376		37 478
1963	77 354		8 879	11 981	7 412		105 626
1964					4 072	74	4 146
1965	19 930	16 084					36 014
1966	62 116	800			222		63 138
1967							
1968							
1969							
1970							
1971							
1972	3 774						3 774
1973	49 000		900				49 900
1974	35 000						35 000
1975							
1976	35 520						35 520
1977	1 150						1 150
1978	6 000	2 500					8 500
1979	13 635	1 406	5 225	800		400	21 466
1980	19 898	10 390	5 254			7 610	43 152

a - Whitefish - Mostly broad whitefish
b - Others - Species other than whitefish, Arctic charr, inconnu and northern pike
c - Mixed - A mixture of broad whitefish, lake whitefish, inconnu, lake herring, lake trout, Arctic charr, grayling, pike, burbot, smelt, herring, sucker, lamprey, cod, Arctic sole, starry flounder and fourhorn sculpins.

Table 13. Commercial fish (weight in pounds) sold locally from catches within and adjacent to the Mackenzie Delta, 1978. MD = Mackenzie Delta and Tuktoyaktuk Harbour; PR = Peel River; ARR = Arctic Red River; HR = Hornaday River near Paulatuk.

Fish	MD	PR	ARR	HR	Total
Salvelinus alpinus	350	240		13 250	13 840
S. namaycush					
Coregonus autumnalis					
and *C. sardinella*					
C. clupeaformis		400	1 200		1 600
C. nasus	1 250	2 640	2 000		5 890
Stenodus leucichthys		100			100
Thymallus arcticus				4	4
Esox Lucius		220			220
Catostomus catostomus				2	2
Lota lota		120		3	123
Total	1 600	3 720	3 200	13 259	21 779

Table 14. Commercial fish (weight in pounds) sold locally from catches within and adjacent to the Mackenzie Delta, 1979. Mackenzie Delta areas (MD 1-5)[a] are indicated in Figure 8. ARR = Arctic Red River and Tree River; HR = Hornaday River, near Paulatuk; NL = Noel Lake; SL = Sitidgi Lake; FH = Fish Hole, west of Aklavik; SP = Shingle Point, Mackenzie Bay.

Fish	MD1	MD2	MD3	MD4	MD5	ARR	HR	NL	SL	FH	SP	Total
Salvelinus alpinus	1 500						14 948[b]					16 448
S. namaycush									160			160
Coregonus autumnalis												
and *C. sardinella*												
C. clupeaformis		2 000						262				2 262
C. nasus	1 550	9 259	3 350		1 200	1 880						17 239
Stenodus leucichthys		2 900	550			1 000						4 450
Thymallus arcticus												
Esox Lucius		800										800
Catostomus catostomus												
Lota lota												
Total	3 050	14 959	3 900		1 200	2 880	14 948	262	160			41 359

[a] In responding to survey forms, most individuals indicated where they obtained their catch. These fishing locations were assigned to the Mackenzie Delta areas (1-5) delineated for commercial management areas (Figure 8). If information on fishing locations was not provided, catches were assigned to delta areas based on residency: Fort McPherson was assigned area 1; Inuvik, area 2; Aklavik, area 3; Tuktoyaktuk, area 5.

[b] Of 14 948 lb, 12 459 lb were sold to Committee for Original People's Entitlement (COPE).

Table 15. Commercial fish data (weight in pounds) for the Mackenzie Delta and adjacent areas, 1980. Mackenzie Delta areas (MD 1-5) are indicated on Figure 8. ARR = Arctic Red and Tree Rivers; HR = Hornaday River, near Paulatuk; NL = Noel Lake; SL = Sitidgi Lake; FH = fish hole, west of Aklavik; SP = Shingle Point, Mackenzie Bay.

Fish	MD1	MD2	MD3	MD4	MD5	ARR	HR	NL	SL	FH	SP	Total
Salvelinus alpinus			3 284				516					3 800
S. namaycush	760								600			1 360
Coregonus autumnalis					200							200
and *C. sardinella*												
C. clupeaformis						1 400			50			1 450
C. nasus	320	1 298	5 040		200	2 858			100			9 816
Stenodus leucichthys		138	120		200	125						583
Thymallus arcticus												
Esox lucius												
Catostomus catostomus												
Lota lota												
Total	1 080	1 436	8 444		600	4 383	516		750			17 209

[a] see footnote 'a' on Table 14.

Table 16. Estimates of annual harvests (pounds) of domestic fish in the Mackenzie Delta (M.D.) and environs.

Year	Locale	Number of Estimated Pounds	References
1960-61	M.D. excluding Tuktoyaktuk	950 000	Usher (1975)
1960-61	Tuktoyaktuk	735 000	"
1960-61	Coppermine R.	150 000	"
1961-62	Inuvik and Aklavik	113 000	Sinclair et al (1967)
1961-62	Fort McPherson	506 040	"
1961-62	Arctic Red River	74 600	"
1962	M.D. excluding Tuktoyaktuk	2 700 000	Olesh (1979)
1963	"	1 750 000	"
1964	"	2 000 000	"
1965	Inuvik	350 000	Wolforth (1966)
	Aklavik	500 000	"
	Tuktoyaktuk	600 000	"
	Reindeer Station	100 000	"
	Fort McPherson	550 000	"
	Arctic Red River	110 000	"
1965-66	Banks Island	2 000	Usher (1975)
1970-71	"	2 000	"
1970-71	M.D. excluding Tuktoyaktuk	166 000	"
1971	Arctic Red River	50 000	Hunt (1972)
1972	M.D. and Tuktoyaktuk	111 000	DIAND/MPS (1973)
1972	Fort McPherson, Arctic Red River	450 000	"
1972	Big Fish River	3 000 - 5 000	Hunt (1973)
	Fish Hole	5 000 - 7 000	"
	Rat River	6 500	"
1973	Aklavik	994 306	"
1973	Arctic Red River	129 465	Jessop et al (1974)
1973	Aklavik	295 000	Olesh 1979
	Inuvik	99 750	"
	Tuktoyaktuk	172 900	"
1975	M.D. excluding Tuktoyaktuk, Paulatuk, Banks Island and Holman	690 400	"
		189 000	"

Table 17. Domestic fish data (weight in pounds) for the Mackenzie Delta and adjacent areas[a], 1978. MD = Mackenzie Delta and Tuktoyaktuk Harbour; PR = Peel River; ARR = Arctic Red River; HR = Hornaday River, near Paulatuk.

Fish	MD	PR	ARR	HR	Total
Oncorhynchus keta	50	12	16	50	128
Salvelinus alpinus	400	1 360		7 220	8 980
S. namaycush[b]					
Coregonus autumnalis	3 800	900	100		4 800
and *C. sardinella*					
C. clupeaformis	11 380	8 800	2 400		22 580
C. nasus	10 680	14 360		1 050	26 090
Stenodus leucichthys	3 115	1 240	260		4 615
Thymallus arcticus	92			100	192
Esox lucius	895	2 400	48		3 343
Catostomus catostomus	102	168		100	370
Lota lota	1 980	920	160	200	3 260
Total	32 494	30 160	2 984	8 720	74 358

[a]Although locations of fish captures were not indicated on the request forms, most individuals volunteered general fishing areas.

[b]*S. namaycush* (lake trout) was not listed on 1978 request forms.

Table 18. Domestic fish data (weight in pounds) for the Mackenzie Delta and adjacent areas, 1979. Mackenzie Delta areas (MD 1-5)[a] are indicated on Figure 8. ARR = Arctic Red and Tree Rivers; HR = Hornaday River, near Paulatuk: NL = Noel Lake: SL = Sitidgi Lake; FH = Fish Hole, near Big Fish River; SP = Shingle Point, Mackenzie Bay.

Fish	MD1	MD2	MD3	MD4	MD5	ARR	HR	NL	SL	FH	SP	Total
Oncorhynchus keta	60	12	68				80			120		340
Salvelinus alpinus	6 732	16	36	12			3 440			600	640	11 476
S. namaycush	1 700	54	9	80	4		60	60				1 967
Coregonus autumnalis	6 500	2 345	200	150	4 603	200					500	14 498
and *C. sardinella*												
C. clupeaformis	3 218	42 664	18 900	7 160	6 680	2 500		860	320			82 302
C. nasus	9 726	21 094	23 600	3 380	6 820	8 520	1 140		36		2 000	76 316
Stenodus leucichthys	1 830	4 579	1 752	600	1 400	1 340						11 501
Thymallus arcticus	100	16				280	60			300		756
Esox lucius	6 078	9 884	6 930	900	244	1 040			16			25 092
Catostomus catostomus	252	400	754		80	880						2 366
Lota lota	2 528	4 088	6 962	1 200	464	180			28			15 450
Total	38 724	85 152	59 211	13 482	20 295	14 940	4 780	920	400	1 020	3 140	242 064

[a]See footnote 'a' on Table 14.

Table 19. Domestic fish data (weight in pounds) for the Mackenzie Delta and adjacent areas, 1980. Mackenzie Delta areas (MD 1-5)[a] are indicated on Figure 8. ARR = Arctic Red and Tree Rivers; HR = Hornaday River, near Paulatuk; NL = Noel Lake; SL = Sitidgi Lake; FH = Fish Hole, near Big Fish River; SP = Shingle Point, Mackenzie Bay.

Fish	MD1	MD2	MD3	MD4	MD5	ARR	HR	NL	SL	FH	SP	Total
Clupea harengus					500							500
Oncorhynchus keta	192		384			64						640
Salvelinus alpinus	884		3 424			800	1 804			180		7 092
S. namaycush	4 230		4 960				100			2 000		11 290
Coregonus autumnalis	5 884	3 500	3 728		2 950	800						16 862
and *C. sardinella*												
C. clupeaformis	19 404	7 322	15 832	540	600	9 840			70		120	53 728
C. nasus	15 312	4 516	37 272	2 180	2 480	9 860	240		80		1 600	73 540
Stenodus leucichthys	2 376	1 848	4 024	1 264	1 120	5 168						15 800
Thymallus arcticus	100		80	160			80			400		820
Esox lucius	5 132	2 646	9 556	120		3 400						20 854
Catostomus catostomus	248	8	604	200		640	24					1 724
Lota lota	5 316	2 490	12 452	600	148	1 324	40			20		22 390
Total	59 078	22 330	92 316	5 064	7 798	31 896	2 288		150	2 600	1 720	225 240

[a]See footnote 'a' on Table 14.

Table 20. Fish harvest (lb) for all fish caught in the Mackenzie Delta (Areas 1-5). 1 lb = 0.45 kg.

Year	Domestic	Commercial Local	Commercial FFMC[c]	Total
1978[a]	65 638	8 520	8 500	82 658
1979	231 804	25 989	21 466	279 259
1980[b]	218 482	15 943	43 152	277 577

[a]In 1978, fished areas included the Mackenzie Delta and nearby Peel River. Response to the first harvest questionnaire in 1978 was poor. Thus, total catch for 1978 is greatly underestimated.

[b]For this study, the 1980 data for domestic and local commercial fish was based on all responses received by R. T. Barnes, until February 26, 1981. Most commercial license holders had responded by this date.

[c]Freshwater Fish Marketing Corporation.

Table 21. Monthly distribution of sport fishing activity in the Northwest Territories in 1975 (after D. Topolniski MS. in preparation).

Month	Number of Anglers	Number of Angler Days
January	73	147
February	164	351
March	201	646
April	275	932
May	1 528	5 507
June	3 821	18 689
July	6 619	38 428
August	5 186	28 931
September	2 442	10 367
October	485	1 699
November	129	405
December	82	173
Total		106 275

Total number of active anglers in 1975: 10 675

Table 22. Number of sports fishing licences issued in the Northwest Territories (after Fenge et al 1979).

Year	Resident	Canadian Non-Resident	Non-Resident
1970-71	1 439	-	4 550
1971-72	3 346	-	3 238
1972-73	4 772	-	3 352
1973-74	5 742	-	3 602
1974-75	4 092	2 631	3 945
1975-76	4 851	2 865	3 659

Table 23. Angler fish harvest in the Northwest Territories during 1975 (after D. Topolniski MS. in preparation).

Species	Number of Fish Caught and Retained	Live Weight Equivalent (lb)	Mean Weight (lb)
Arctic charr	8 700	69 800	8.0
Arctic grayling	30 700	61 400	2.0
lake trout	47 200	378 700	8.0
northern pike	46 600	349 000	7.5
walleye	22 300	44 600	2.0
whitefish	8 800	26 500	3.0
other	7 400	22 200	3.0
Total	168 700	952 200	

Table 24. The distribution of licenced anglers within the Northwest Territories according to recreational areas (see Fig 9). Data obtained from D. Topolniski (DFO Winnipeg).

Area	Number of Anglers Who Fished
1	1 615
2	1 438
3	979
4	1 267
5	3 234
6	218
7	2 619
8	988
9	2 050

Table 25. Angling harvest estimates from camps and outfitters in the Mackenzie Delta and environs.

Waterbodies	Year	Fish Caught	Harvest (lb/year)
Hazen Lake	1975-80	Arctic charr (searun)	1 000
		Arctic charr (landlocked)	50
Hornaday River	1980	Arctic charr	-
		Arctic grayling	-
Char Lake, Victoria I.	1980	lake trout	(6 lb/fish)
		Arctic charr	*
Sitidgi Lake and Husky Lakes	1975-79	lake trout	400 - 600
		Arctic grayling	100
	1980	lake trout	200 - 300
		Arctic grayling	50